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NOVEMBER/DECEMBER 2005

PASSIVE COMPONENT INDUSTRY

Electronic Industries Alliance

An affiliate publication of the EIA
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The Only Magazine Dedicated Exclusively to the Worldwide Passive Electronic Components Industry

Aluminum and Film Capacitors

Surface-Mount Aluminum Electrolytic Capacitors and Pb-Free Reflow

Film Capacitors for Power Electronic Application

Man Yue: Company Profile

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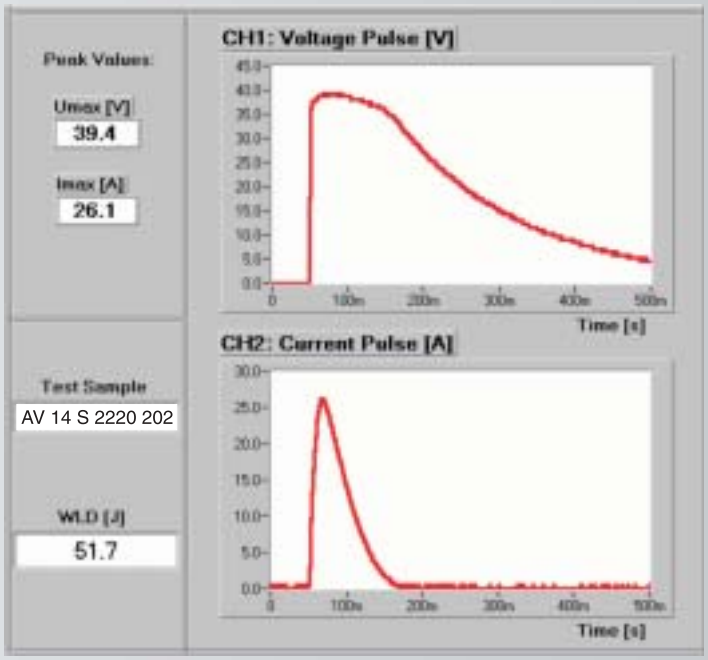

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PASSIVECOMPONENT INDUSTRY

Around the World in Nine Days

Before I could write this letter, I had to fly from Raleigh, North Carolina to Cleveland, and on to Los Angeles, Taipei, Tokyo, back to Taipei, then to Bangkok, Amsterdam, Prague, New York, and back home to Raleigh. Due to the time proximity of the first CARTS Asia in Taipei, and the 19th CARTS Europe in Prague (held the following week), I thought I'd be young and bold enough to detour so I could debate with JEITA and its passive component members in Tokyo during this trip.

Part of my motivation was to actually fly around the world in nine days. I have lived in North Carolina for more than 10 years, and am always amazed by the stone markers at Kitty Hawk that mark the length of each of the Wright Brothers' trial flights, and how they achieved such minor, almost debatable levels of success early on. Some of their successes were literally measured only in meters, until their last flight when their success was apparent because they covered such a great distance. Hence, the definition of controlled flight came into the vernacular; and yet this distance, such a tremendous stride for mankind in 1903, equalled the length of the modern Boeing 747. I wanted to join the list of those who have traveled around the world (it must be a limited list because it has been only 102 years since Wilbur and Orville converted their bicycle/kite/two stroke into an airplane). And this was a list I wanted to be on. Around the world in nine days.

Dennis M. Zogbi

During the trip, with great expanses of time and freedom of thought and openness of mind, I conducted mathematical experiments, easing my mind with algebra and geometry equations until I was relaxed. Somewhere over Kashmir, I am most sure, I thought of Einstein and how my mathematical equation would suggest that, in the end, I would go back in time by six hours. And this is what occurred at the end of this journey—I did go back in time by six hours, but felt as if I had aged ten years. So I conclude, based upon the empirical equations at hand, that if we go back in time the journey will kill us; so we must get young by growing old gracefully.

CARTS Asia

The first Capacitor & Resistor Marketing Seminar, held in October of 2005 in conjunction with Taitronics and with support from TEEMA, was a success, insomuch as more than 50% of the attendees signed up at the door. I thought of giving away free prizes for those who actually found the room where the marketing seminar was being held. Taitronics was massive, with about 30,000 attendees on that day and hundreds of booths selling all things electronic. (I think I bought a fog machine for the office but am not sure until I get the American Express bill; I may have just contributed to a fund to increase fog machine awareness.) However, my marketing seminar was focused specifically on the broad spectrum of dielectrics and resistive elements produced and consumed—not just in Asia—but also worldwide. My seminar dealt initially with methodology for using market research to determine passive component production and consumption. This process reassured the audience that the data was well balanced. I explained that my company, Paumanok Publications, Inc., uses a Box-Jenkins Method of research whereby we track raw material usage and supply, production, distribution, and consumption by end product and region—and that this process must

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PASSIVE COMPONENT INDUSTRY

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Two Weeks, Two Cultures, Two Events

By Bob Willis,
President, ECA

ECA sponsored the CARTS Asia and CARTS Europe events on consecutive weeks in October, 2005, bringing information on trends and new developments in passive electronic components to two very different cultures. Here is a first-hand account of my experience during those two weeks.

Friday, October 7
Dulles Airport, Washington, D.C.: As I pass people of many nationalities in Dulles Airport, I wonder if any of them are here to give or take from the reservoir of knowledge that has made the United States the gold standard for the next "big thing." I'm on my way to visit economies outside the USA to help kindle an exchange of expertise and knowledge that I hope will advance technology.

LAX Airport: I'm on the phone with the ECA chairman, discussing our efforts at EDS to address global electronic components distribution. We agree that distribution is global in nature but regional in practice.

Monday, October 10
Taipei World Trade Center: CARTS Asia will be part of TAITRONICS, the largest electronics exhibition in Asia. Exhibit construction is almost complete, and the show floor is anchored by corporate icons that represent the dynamic global footprint of the Taiwan electronics industry—an industry that accounts for more than 49 percent of the total industrial production in Taiwan, more than NT$5 trillion of an estimated NT$11 trillion output.

Mr. Y.C. Chao, President of Taitra, Speaks at Opening Ceremony

Tuesday, October 11
TAITRONICS: CARTS Asia 2005 begins. Simultaneous translation is a necessity. More than 75 engineers and designers take part in the morning seminar on new technologies for passive electronic components.

AITRA Chairman Hsu, TEEMA Chairman Hsu, and Taiwan Vice President Lu open TAITRONICS Autumn 2005 session before a packed audience of VIPs from the Taiwanese electronics industry. CARTS Asia is welcomed to TAITRONICS, and ECA representatives help cut the ribbon to open the show. More than 65,000 will attend

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Robustness of Surface-Mount Aluminum Electrolytic Capacitors When Subjected to Pb-Free Reflow

By N. Blattau[1], J. Wright[2], R. Schatz[2], and C. Hillman[1]

Abstract

In addition to a change in materials, the movement to Pb-free will also result in significantly higher temperatures during surface-mount assembly. Initial attempts at surface-mount reflow have noted the initiation of case deformation aluminum liquid electrolytic capacitors in a surface-mount configuration (V-chip). Of special concern is not only the visually observable change in component dimensions, but the possibility of damaged capacitors escaping into the field and inducing widespread field returns. To assess this issue, a wide range of V-chip capacitors was subjected to two series of experiments. In the first set, capacitors of various size and electrolyte formulation were exposed to a modified reflow condition, where the peak temperature was maintained until deformation of the aluminum housing was observed. Based on time to deformation determined in this experiment and the reflow parameters defined in J-STD-020C, a more limited population of V-chip capacitors was exposed to simulated reflow conditions and then subjected to highly accelerated life tests. Results suggest that the strongest predictor of deformation is the volume of the capacitor, with the smallest and largest case sizes having the potential to deform during reasonable Pb-free reflow conditions. When exposed to elevated temperature conditions designed to accelerate electrolyte evaporation, V-chip capacitors showed limited differentiation in time to failure as a function of reflow conditions or the presence or absence of case deformation.

Introduction

The transition to Pb-free manufacturing, to ensure compliance with RoHS legislation, has resulted in substantial concern over the possibility of unknown reliability issues in product released to customers. One particular area of concern has been the observation of bulged or deformed surface-mount aluminum liquid electrolyte capacitors (aka, V-chip) subjected to temperatures recommended for Pb-free reflow (Figure 1). Initial reports have simply been limited to observation, with little to no quantitative information available on process guidelines or degradation in capacitor performance.

The purpose of this investigation was to provide the industry with an initial accounting of the susceptibility of V-chip capacitors to case deformation and assess the potential for potential reliability issues after exposure to Pb-free reflow conditions.

Figure 1: Aluminum Liquid Electrolytic Capacitor, on the Left, Has Experienced Case Distortion after an Extended Time at Pb-Free Reflow Temperatures

Sample Population

Ranges of electrolytic capacitor part types were selected to investigate the influence of electrolyte formulation, capacitor dimensions, and rated voltage. A listing of the various capacitors used in this investigation is provided in Table 1. All capacitors were subjected to an initial inspection to identify any potential anomalies or defects. No anomalies were identified.

Reflow Sensitivity

Reflow sensitivity level (RSL) describes the potential for surface-mount aluminum liquid electrolytic capacitors to experience deformation or degradation when exposed to

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elevated reflow temperatures for extended periods of time. To assess reflow sensitivity, the capacitors were subjected to a modified Pb-free reflow profile.

Experimental Procedure

Three capacitors of the same part type were placed in a reflow simulation chamber. The temperature in the chamber was regulated using a K-type thermocouple, which was attached with Kapton tape to one of the capacitors on the top of its aluminum housing.

Series	Capacitance (µF)	Tolerance	Voltage (VDC)	Size (h x d) (mm)	Rated Lifetime
NACETP[1]PT	10	20%	16	3X5.5	2000 hrs at 85˚C
NACE	1	20%	50	4X5.5	2000 hrs at 85˚C
NACE	10	20%	50	6.3X5.5	2000 hrs at 85˚C
NACEWTP[2]PT	100	20%	16	6.3X5.5	1000 hrs at 105˚C
NACEW	1000	20%	6.3	6.3X5.5	1000 hrs at 105˚C
NACHLTP[3]PT	33	20%	25	6.3X6.1	5000 hrs at 105˚C
NACE	22	20%	63	6.3X8	2000 hrs at 85˚C
NACE	220	20%	35	8X10.5	2000 hrs at 85˚C
NACTTP[4]PT	47	20%	35	8X10.5	1500 hrs at 125˚C
NACT	220	20%	25	10X10.5	1500 hrs at 125˚C
NACE	330	20%	50	12.5X14	2000 hrs at 85˚C
NACE	3300	20%	16	16X17	2000 hrs at 85˚C

[1]NACE is a general purpose capacitor rated from –40 to +85˚C
[2]NACEW is a general purpose capacitor with a wider temperature range (–55 to +105˚C)
[3]NACHL is an extended lifetime capacitor rated from –40 to +105˚C
[4]NACT is a general purpose capacitor with an extended temperature range (–40 to +125˚C)

Table 1: Surface Mount Electrolytic Capacitors Subjected to Reflow Sensitivity Analysis

The time/temperature behavior was adjusted to ensure a preheat and ramp rate that was representative of a Pb-free reflow profile. The specific parameters chosen were based upon IPC/JEDEC J-STD-020C Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State surface-mount Devices (Figure 2). Capacitors were ramped up to a preheat temperature of 190˚C at a rate of 3˚C/sec. This temperature was maintained for 120 seconds and increased to the peak temperature at a rate of 3˚C/sec. The capacitors were then held at the peak temperature until physical deformation of the aluminum housing was observed.

The peak temperatures chosen were 235˚C and 260˚C. These temperatures were based upon the minimum recommended reflow temperature for tin/silver/copper (SAC) solder alloys and the maximum expected peak temperature detailed by J-STD-020C.

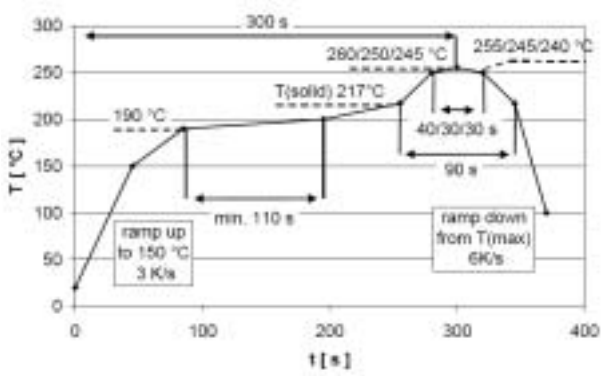

Figure 2: Pb-Free Reflow Profile Detailed in J-STD-020C

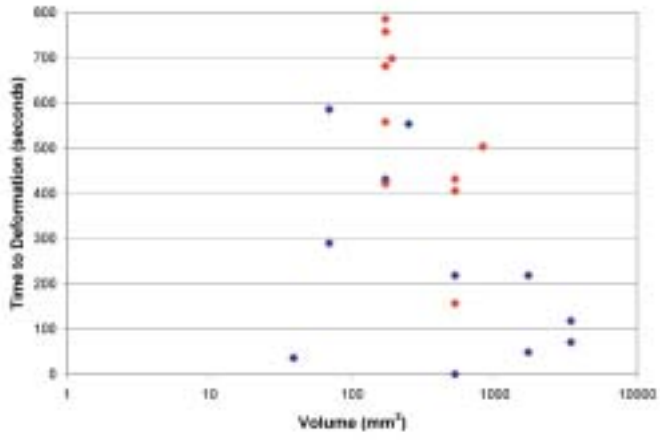

Figure 3: Time to Deformation As a Function of Capacitor Volume at 235˚C Peak Reflow Temperature. The Diamonds in Red Are Indicative of Extended Temperature or Extended Life Capacitors

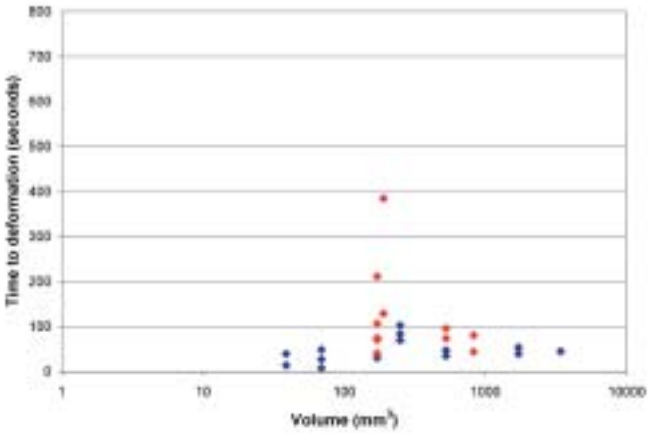

Figure 4: Time to Deformation As a Function of Capacitor Volume at 260˚C Peak Reflow Temperature. The Diamonds in Red Are Indicative of Extended Temperature or Extended Life Capacitors.

Results

The results for time to deformation at 235˚C and 260˚C peak temperature are displayed in Figure 3 and Figure 4, respectively. One capacitor experienced deformation during the ramp up to the 235˚C peak temperature, and is therefore not displayed in Figure 3.

Discussion

Several trends were identified upon review of the preliminary results displayed in Figure 3 and Figure 4. The time to deformation seemed to be strongly dependent upon the volume of the capacitor, with the maximum time to deformation observed to occur at moderate volumes (100 to 500mm^3). The smallest and largest capacitors seemed to be most prone to deformation, with the smallest capacitors at 235˚C and several more capacitors at 260˚C experiencing deformation before the 40 second hold time defined in J-STD-020C. This may suggest that the smallest and largest surface-mount aluminum liquid electrolytic capacitors could experience deformation in more severe Pb-free reflow conditions.

The dependency on volume is expected, based upon the steps involved in case deformation. The first step is introducing a sufficient amount of energy into the system to raise the temperature beyond the boiling point of the electrolyte. The temperature on the outside of the capacitor, where the thermocouple was placed, can be considered the energy flowing into the system. The heat capacity of the electrolyte, which relates energy introduced into the system to a ΔT, is dependent upon the moles of electrolyte present in the system. Therefore, for a given outside temperature, the smaller capacitors will equilibrate with the ambient conditions more rapidly than larger capacitors.

As the boiling point is reached, the vapor pressure will increase rapidly. The larger the volume of liquid present, the larger the pressure within the cylinder for a given temperature. The case resisting the pressure, the surface area, scales with dimensional unit squared. Since the pressure in the can that induces deformation scales with dimensional unit cubed, it can be seen how larger electrolytic capacitors could be more susceptible to earlier deformation.

In general, extended temperature or extended lifetime capacitors displayed a less severe sensitivity to reflow conditions, with all extended temperature/lifetime capacitors having a time to deformation exceeding 40 seconds.

While deformation behavior as a function of reflow temperature and capacitor volume was demonstrated, of greater concern is the possibility that capacitors that did not experience deformation may have experienced some degree of unobservable damage or degradation that would result in a limited lifetime.

Sample Set	Part Number	Reflow Conditions		
		Benign	As per J-STD-020C	Severe
Volume < 350 mm³	NACE1R0M50V4X5 NACE220M63V6.3X8	235˚C / 30 sec	250˚C / 30 sec 250˚C / 40 sec	260˚C/ 30 sec
Volume > 350 mm³	NACE331M50V12.5X14	235˚C / 30 sec	245˚C / 30 sec 245˚C / 40 sec	260˚C/ 30 sec
Extended Lifetime	NACHL330M25V6.3X6.1	N/A	N/A	260˚C/ 20 sec

Table 2: Experimental Design Selected for Assessing Long-Term Degradation

Long-Term Degradation

To assess the potential of degradation during exposure to Pb-free reflow conditions, a limited sample set of capacitors listed in Table 1 were subjected to a range of peak reflow temperatures and hold times. Due to the behaviors observed during the first set of experiments, the sample set was primarily based on volume, with an extended lifetime part also selected for comparison purposes. The experimental design is detailed in Table 2. Three capacitors from each part number were exposed to each reflow condition.

Experimental Procedure

After exposure to the reflow conditions detailed in Table 2, the capacitors were subjected to accelerated test conditions. The accelerated test conditions used to assess degradation behavior were based on previous experiments performed on electrolytic capacitors, which determined that testing to industry specifications would be insufficient to assess long-term reliability. The test temperature was selected to ensure capacitor failure within a reasonable time period without inducing inappropriate failure modes. In addition, since damage to the seal during reflow was the primary concern, a high temperature was desirable to ensure that evaporation of the electrolyte was the mechanism that induced capacitor failure.

Given these requirements, the test conditions were set at 25 VDC at 165˚C. The applied voltage helped ensure maintenance of the dielectric without inducing dielectric breakdown. The elevated temperature, while above industry and company specifications, was significantly below the boiling point of the liquid electrolyte (180˚C to 200˚C).

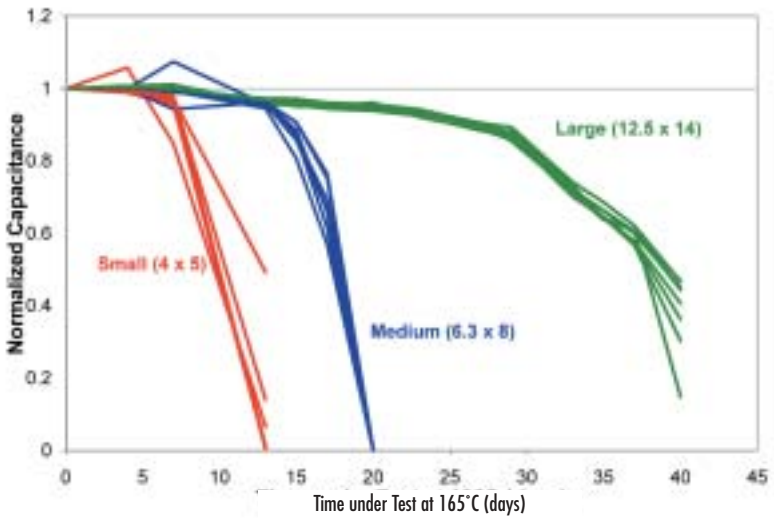

Figure 5: Change in Normalized Capacitance As a Function of Time under Test. Changes in Degradation Behavior by Volume (Small, Medium, Large) Can Be Observed.

Results

Capacitors were periodically pulled from the environmental chamber for capacitance and equivalent series resistance (ESR) measurements. The results are displayed in Figure 5 and Figure 6.

Discussion

The results show that within normal variations, the reflow exposure conditions had no influence on long-term degradation behavior. This observation was found to be true even when the capacitor was observed to have experienced case deformation after Pb-free reflow simulation. The primary influence on time to failure under accelerated test conditions was determined to be capacitor volume. Extended lifetime capacitors were found to have similar degradation behavior to the general-purpose capacitors, as shown in Figure 7.

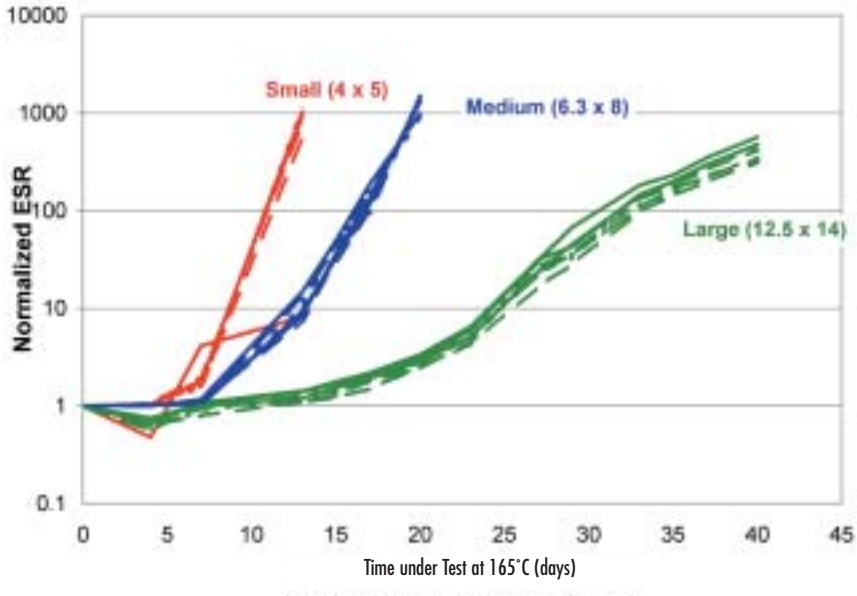

Figure 6: Change in Normalized Equivalent Series Resistance (ESR) As a Function of Time under Test. Changes in Degradation Behavior by Volume (Small, Medium, Large) Can Be Observed.

Conclusion

The potential for case distortion in V-chip capacitors during Pb-free reflow was found to be dependent primarily upon the volume of the capacitor, with small (less than 100 mm^3) and large (greater than 1000mm^3) showing the greatest degree of susceptibility. Capacitors with extended temperature or extended lifetime capacitors in general showed more robust behavior.

Exposure to a range of Pb-free reflow conditions and the occurrence of case deformation seemed to have minimal influence on the reliability of the V-chip capacitors in environments designed to accelerate electrolyte evaporation, the most common root-cause for electrolytic capacitor failure in the field. ❑

[1]DfR Solutions, College Park, MD
[2]NIC Components, Melville, NY

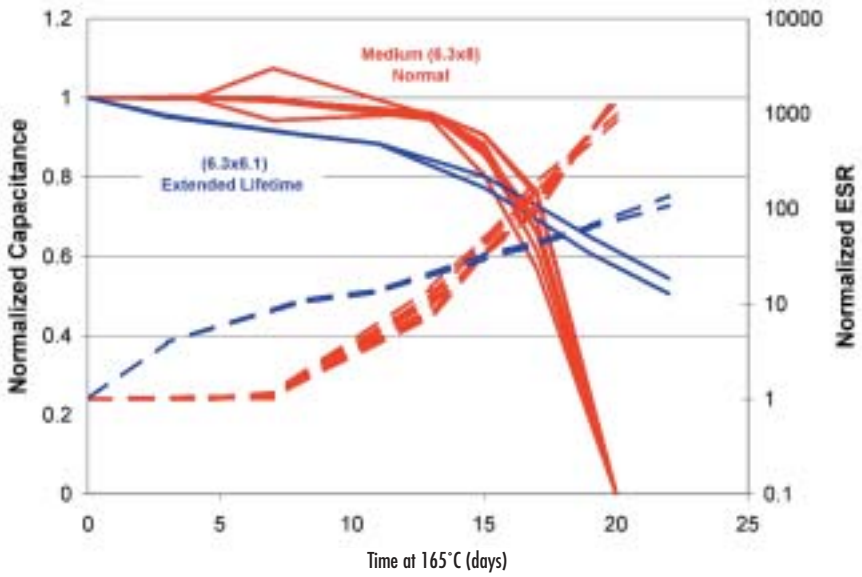

Figure 7: Comparison of Degradation Behavior of General Purpose and Extended Lifetime Capacitors

Film Capacitors for Power Electronic Applications

By Freddy Estaban, EPCOS Electronic Components S.A., Spain
Suresh Chandran, EPCOS, Inc. USA

New power electronics for industrial applications demands higher performance levels from all involved components—semiconductors to passive components—in terms of both electrical and climatic operating conditions. Capacitors are not an exception to these performance demands, and challenging standards are being set, in which the reliability of the product is becoming more and more critical.

In this context, our experience demonstrates that film capacitors offer significant advantages compared to other capacitor technologies. High current capability, low inductance, flexible design, different mounting possibilities, thermal and electrical stability, reliability, and long service life make film capacitors a suitable solution for these applications.

The new developments in film capacitor technology allow the designers of power applications to use new design concepts and advanced control systems for high switching frequency semiconductors. They can now use film capacitors, taking advantage of their excellent performance, rather than other traditional technologies. EPCOS has understood this new trend and offers different series of film capacitors, in different operating voltages, in order to fulfill the technical requirements of every position in the circuit.

Film Capacitors As a Reliable Solution

The high performance of film capacitors is based on different characteristics of the product, which are linked to their internal construction and the properties of the plastic material of which they are composed.

To begin with, the self-healing capability of film capacitors is one of their most important features; it protects the capacitors against catastrophic operating failures and makes them a highly reliable product, in comparison with other technologies.

Film capacitors also offer excellent thermal stability, being able to work within a wide range of temperatures without affecting the product performance. In addition, due to the high electrical stability of this technology, the most important electrical parameters of film capacitors remain constant when modifying the voltage.

Low ESR values and high Irms handling capability, which are needed to work with high frequency ripple current (up to 100KHz) in applications, are other important characteristics of film capacitors.

All these characteristics make film capacitors an optimal solution for many applications in the power electronics field, where they were not previously used.

Self-Healing Property of Film Capacitors

The self-healing capability of film capacitors could be defined as their ability to clear faults (such as pores or impurities in the film) under the influence of a voltage.

The metal coatings, vacuum-deposited directly onto the plastic film, are only 20 to 50nm thick. If the dielectric breakdown field strength is exceeded locally at a weak point, a dielectric breakdown occurs. In the breakdown channel, the high temperatures reached (up to 6000K) transform the dielectric into a highly compressed plasma that forces its way out. The thin metal coating in the vicinity of the channel is totally evaporated by interaction with the plasma, retreating from the breakdown channel. The rapid expansion of the plasma causes it to cool after a few microseconds, thus quenching the discharge before a greater loss of voltage takes place. The insulated region thus resulting around the former faulty area will cause the capacitor to regain its full operational ability.

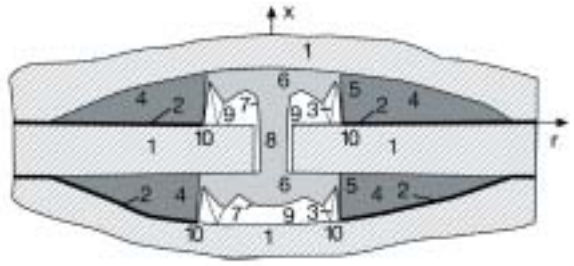

Figure 1: Schematic of the Self-Healing Area during Electrical Breakdown

1. Dielectric
2. Metallized electrodes
3. Material displacing shock wave
4. Air gap with metal vapor
5. Plasma zone
6. Plasma zone
7. Boundary layer between gas phase dielectric and plasma
8. Breakdown channel
9. Gas phase dielectric
10. Zone of displaced metallization and dielectric (insulating region)

Application: Drives

Introduction

The function of an electrical adjustable drive is to control the speed, torque, acceleration, deceleration, and direction of rotation of the motor of a machine. The drives could be direct current drives (DC drives) or adjustable frequency drives (AC drives).

In this sense, any electrical drive typically consists of three basic elements, as shown by the system block diagram in Figure 2.

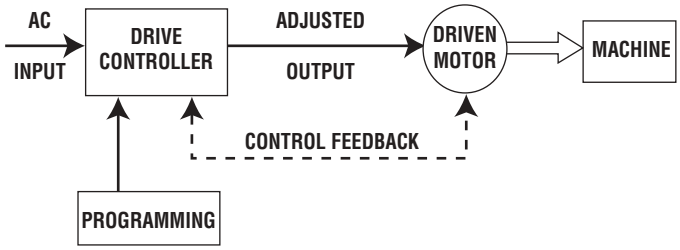

Figure 2: System Block Diagram

DC Drives

DC drives, because of their simplicity, ease of use, reliability, and favorable cost, have been the preferred solution for industrial applications for a long time. In DC drives, the thyristor (a silicon controller rectifier SCR) converts the fixed AC voltage of the power source in the input to an adjustable voltage, controlled direct current (DC) output, which is applied to the armature of a DC motor. The speed and torque of the motor is managed by modifying the output voltage value.

In general, DC drives could be classified in two groups, Nonregenerative DC Drives (which are able to control motor speed and torque in one direction only) and Regenerative DC Drives (which are capable of controlling not only the speed and direction of motor rotation, but also the direction of motor torque).

AC Drives

Adjustable frequency AC motor drive controllers, frequently called inverters, are typically more complex than DC controllers because they must perform two power section functions: conversion of the AC line power source to DC voltage, and finally an inverter change from the DC to a coordinated adjustable frequency and voltage output to the AC motor. Therefore, the speed and torque is controlled by means of the adjustable frequency and voltage level of that AC output voltage.

In spite of its complexity, there is a clear trend in the

Continued on page 15

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market to use AC variable speed drives. This trend has been driven by the desire to emulate the excellent performance of the DC motor (such as fast torque response and speed accuracy), while using rugged, cheap, and maintenance-free AC motors. This is the reason for the fast evolution of these products during recent years.

A number of different types of AC motor controllers are currently in common use as general purpose drives: Pulse Width Modulated (PWM), Current Source Input (CSI), and the Load Commutated Inverter (LCI). Each type offers specific benefits and characteristics, and the selection criterion is based on the final application requirements in terms of voltage and power.

Basic Schematic

As an example, Figure 3 system block diagram represents a general basic schema of a 3-phase DC drive, which could be used to control a DC motor.

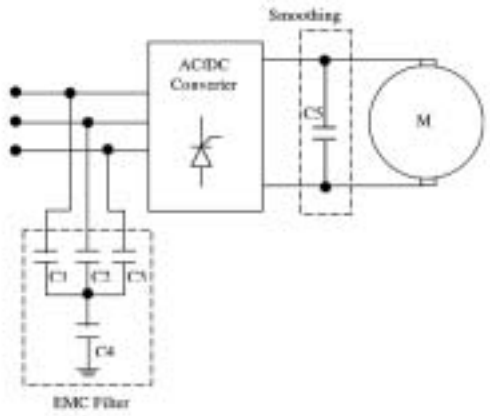


Figure 3: System Block Digram of a 3-Phase DC Drive

On the other hand, for AC motors, a 3-phase AC drive could be represented by the system block diagram in Figure 4:

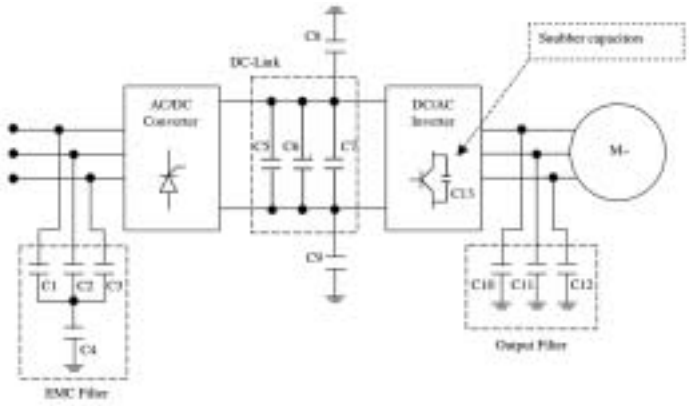


Figure 4: System Block Diagram of a 3-Phase AC Drive

Obviously, the final topology of a particular drive will depend on the real application requirements: different configurations for the EMC filter, output filter, and DC-link stage. Therefore, some of the capacitors that are included in these diagrams might or might not appear in solutions for specific requirements.

Capacitor Requirements

EMC Filter

Normally, across the line and line to ground capacitors are used in this filtering stage. In most cases they have to be X2 and Y2 approved capacitors, in accordance with international regulations. Electromagnetic interference produced by the equipment, if not filtered out by those capacitors, could interfere with the functioning of other devices in the vicinity.

These capacitors work with an AC voltage with 50 or 60Hz frequency. Depending on the voltage level of the 3-phase network (380 to 440V), in particular for X2 capacitors, the rated voltage will be between 275 and 305V, which includes a safety margin of 10%. These capacitors must be able to withstand transients that could suddenly appear in the mains, in order to protect the equipment and its end users against those over-voltages.

With respect to Y2 capacitors, 250Vac is the typical rated voltage, although there is trend in the market to used this product with a higher rated voltage (up to 305Vac).

DC-Link, Switching and Smoothing

Capacitors in the DC-Link module have to support the DC voltage from the AC/DC converter, by supplying high peaks of current when it is required. They also have to work with high frequency ripple current—up to 100Khz—which is superimposed on the signal and is coming from the inverter.

Finally, capacitors in this position have to withstand recurring and non-recurring peak voltages, which are induced by switching or any other disturbance of the system. According to IEC 1071, the peak voltages could be

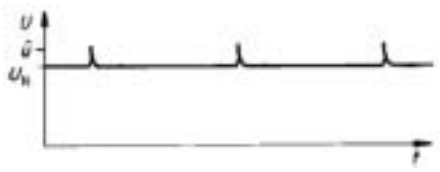


Figure 5: Peak Voltages

50% higher than the capacitor rated voltage.

Therefore, low ESR values, high RMS current capability, high insulation resistance, relatively high capacitance values,

Continued on page 34

Experiencing Rapid Growth in a Mature Market

By Dennis M. Zogbi,
President, Paumanok Publications, Inc.

Man Yue Electronics Company Limited, of Chai Wan, Hong Kong in the People's Republic of China, produces aluminum electrolytic capacitors in five separate configurations. These include radial leaded, axial leaded, surface mount V-chip, screw terminal, and snap-mount versions, which are sold primarily in greater China under the Samxon® brand name.

Man Yue Aluminum Electrolytic Capacitor Products

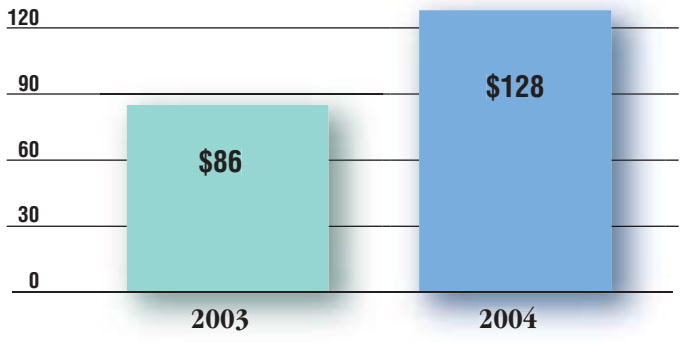
- Radial Leaded Aluminum Capacitors
- Axial Leaded Aluminum Capacitors
- Aluminum Capacitors
- Screw Terminal Aluminum Capacitors
- Snap-Mount Aluminum Capacitors

Forty-Nine Percent Year-over-Year Growth in Revenues

Between 2003 and 2004 Man Yue Electronics reported an increase of 49% in aluminum electrolytic capacitor sales value in one year, with revenues growing from $86 million USD in 2003 to $128 million USD in 2004. This year, 2005, also shows increased year-over-year revenues in aluminum electrolytic capacitors.

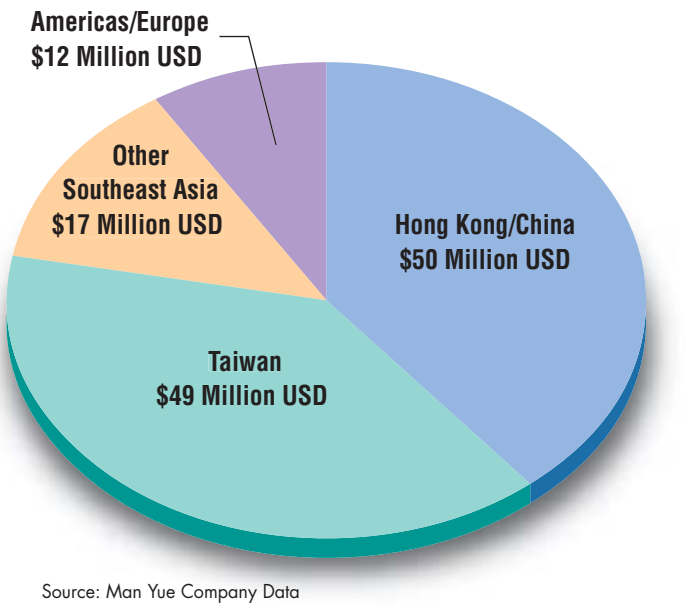
The growth of Man Yue is fascinating because most other top tier suppliers are experiencing only 5% or 10% growth for the year, while Man Yue has distinguished itself with growth rates nearing 50% year-over-year.

Man Yue Year-over-Year Growth in Revenues ($/MM): 2003-2004



Average Annual Growth: 49%
Source: Man Yue Company Data

Man Yue Electronics Revenues by World Region: 2004



Source: Man Yue Company Data

Revenues by World Region: 2004

In 2004, approximately 78% of aluminum electrolytic capacitor revenues for Man Yue Electronics came from sales to greater China, which includes the People's Republic of China, Hong Kong, and Taiwan. An additional 13% of revenues was sourced to other Asian countries outside of greater China, while only 9% of revenues came from North America and Europe combined.

Rapid Growth across the Board on a Region-by-Region Basis 2003-2004

Man Yue Electronics reported rapid growth in all world regions in 2004, with sales into Taiwan increasing by a whopping 96% year-over-year, going from $25 million in revenues in 2003 to $49 million USD in revenues in 2004. Growth in sales of aluminum electrolytic capacitors in mainland China also increased by 19% year-over-year for the company, growing from $42 million in revenues in 2003 to $50 million in revenues for 2004. This growth occurred while sales to other Asian regions increased by 31% year-over-year, growing from $13 million in 2003 to $17 million USD in 2004. Rapid growth was also recorded in sales to the West (USA and Europe), which increased by 71% year-over-year, from $7 million USD in 2003 to $12 million in 2004.

Man Yue Electronics–Growth by Country/World Region: 2003-2004			
Region	2003 USD	2004 USD	% Change
Hong Kong/China	$42 Million	$50 Million	+19%
Taiwan	$25 Million	$49 Million	+96%
Other Southeast Asia	$13 Million	$17 Million	+31%
Americas/Europe	$7 Million	$12 Million	+71%
Grand Total	$86 Million	$128 Million	+49%
Source: Man Yue Company Data			

Production Facilities and Capacity to Produce: 2004

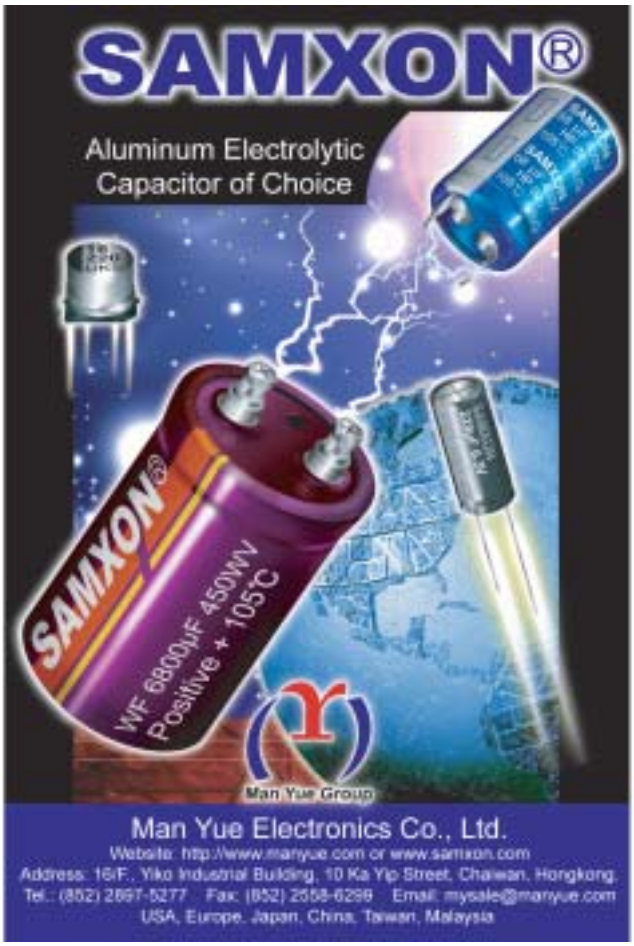
Man Yue Electronics maintains three major production facilities for aluminum electrolytic capacitors in China. These include the Samxon Dong Guan plant, the Wuxi Heli Electronics plant, and the Man Yue Xiamen plant; the combined monthly output capacity is 520 million pieces per month, or 6.2 billion pieces per year.

The Samxon plant in Dong Guan was established in 1994 and represents the largest production facility for the company, with monthly production capacity for aluminum electrolytic capacitors at 400 million pieces (4.8 Billion Pieces Annualized). The plant, which is located in the Xin An Industrial Area, employs 2,500 people and occupies 50,000 square meters.

Man Yue's Wuxi Heli Electronics plant, which also opened in 1994, is located in Wuxi, People's Republic of China. It has a monthly production capacity of 80 million aluminum capacitors per month (960 billion pieces annualized).

Man Yue's newest plant, which was opened in 2002, has monthly production capacity of 40 million aluminum electrolytic capacitors, or 0.5 billion pieces per year. The plant, occupying 2,300 square meters and employing 132 people, is

Samxon Dong Guan Plant



Man Yue Electronics–Capacitor Production by Factory		
Plant	**Monthly Output**	**Annual Output**
Samxon/DongGuan, PRC*	400	4,800
Wuxi Heli/Wuxi PRC*	80	960
Man Yue, Xiamen, PRC*	40	480
Grand Total	520	6,240
*Peoples Republic of China Source: Man Yue Company Data		

located in Xiamen province, People's Republic of China.

Reasons for Growth in 2004 and 2005

According to senior executives of Man Yue Electronics, their growth in 2004 and 2005 is directly related to the fact that they are a quality supplier in Mainland China to global EMS and OEM electronics firms. These firms are now asking the company to export to other customer locations throughout the world. The rapid growth of the company in Taiwan and in the West in 2004 and 2005 is directly related to this new phenomenon that is affecting other Chinese producers of quality product lines, both inside and outside the electronics industry. ❑

Mr. Michael Chan, Chairman of Man Yue Group

Thicker Layers on Thinner Substrates

By Peter Olbrich,
Applied Films

Ultra Thin Film (UTF) coating for thin film capacitors requires advanced metallizing equipment. Reliable, robust, and state-of-the-art production features are needed to produce thin film capacitors efficiently, with high throughput and best quality. Improvements have focused on winding systems, patterning modules, and possibilities to enhance film properties in-line during the coating process.

Emerging Markets for Thin Film Capacitors

Advancing thin film capacitor applications, combined with further developments in coating technology over the past five years, are opening new market areas for film capacitors. So far, these areas had been covered by ceramic and electrolyte capacitors. One main reason for the expansion of the film capacitor market is the innovation in production processes, especially in the field of metallizing.

It is now within every producer's capability to deposit layers up to 60nm (i.e. approx. <1.5 Ohm/sq) on dielectric substrates from 0.5 to 20µm in thickness when using the latest production systems, such as the Applied Films metallizer MULTIMET™. Metallizing is the deposition of conductive material for the electrodes on thin dielectric substrate. Depending on the layer thickness required and the conductive material to be deposited, the metallizing process occurs at production speeds up to 20meter/second at extremely high accuracy.

In addition to the primary films that are used for capacitors, BOPP (Polypropylene) and PET (Polyethyleneterephtalat), special types like PEN (Polyethylenenaphtalate) and PPS (Polyphenylenesulphide) are being used in rising quantities for special applications such as dielectric base substrates for film capacitors. Passive components made of these substrates can be used in automotive applications such as converters in integrated starter generators for cars, high intensity discharge lamps, or mobile phones.

PET: The Future Material for Ultra Thin Film (UTF)

According to film manufacturers of PET, the market continues with a stable demand, but they observe a clear trend to thinner substrates below 2.7µm, the so-called "Ultra Thin Film" (UTF). The total monthly quantity supplied for PET film capacitor applications is around 950 tons. There's no increase in quantity, but thinner materials are becoming more and more important. Currently the monthly quantity for UTF grades is around 50 tons/month. Geographically, the demand for PET is moving to China. Film suppliers are following this trend by expanding their local PET production capacity. Nearly all PET manufacturers offer different film types: less shrinkage (for SMD applications), standard rough film, and smooth film for further minimization of film capacitors.

Commercial use of thin film focuses on UTF grades at 0.7 and 0.9µm PET. The product portfolio of these grades meets the full range of film requirements for different surface topographies and different thermo-mechanical properties.

PET suppliers are reporting a substitution of ELCOs (Electrolytic Capacitors) by PET capacitors—and vice versa—according to different requirements for capacity, voltage-/impulse strength, and price. The so-called "Mild Hybrid" is an example of a new technology: metallized PET capacitors consisting of 1-2µm dielectric film are operating at e.g. 42V as converters in "integrated starter generators" in the automotive industry. Car manufactures see a reduction of fuel and emissions by using this type of capacitor. Another innovation is a PET SMD version, supporting applications that require either long-term resistance to high temperatures or the capability to withstand temperature peaks.

PEN: Niche Applications

As reported from the market, demand for PEN is still at a low level and prices for the raw material did not drop as expected, due to the increasing demand for products like PET bottles.

Film manufacturers are reporting that PEN is used in a smaller number of applications. The high heat resistance of >150°C for PEN gives it an advantage against PET. For example, in automotive applications like the high intensity discharge lamps (HID lamps) PEN is less expensive than PPS.

PPS: Booming in Highly Demanding Technical Applications

It has been announced that PPS capacities will be enhanced with a new plant. There are many reasons for the increasing demand for PPS. On one hand it is used in technical applications for LCD displays and PPS SMD capacitor types in mobile phones, which increases demand for PPS where highly reliable chip capacitors are mandatory. "Highly reliable" in this context means minimum capacity variation, high heat resistance (>170°C), and short response times at high frequencies. With the best electrical and thermal properties, the slightly larger and more expensive PPS capacitors provide a competitive alternative to existing MLCCs (Multi Layer Ceramic Capacitors).

The variety of different film types mentioned above requires metallizing systems which are easily and quickly adaptable to different substrates. Only this process flexibility enables the economic production of thin films for capacitors of the highest quality on a mass production level.

Capacitor Design Needs Support to Converge to Flexibility

Advanced UTF metallizing systems must enable the fulfilment of design ideas using different substrate materials and conductive materials. It is this design support of the vacuum metallizing system which lets capacitor designers truly benefit from the increasing variety of materials.

Electrode materials including aluminum, zinc alloys, copper, and silver can be applied to ultra thin substrates comprising most dielectrics on the market. Dielectric thickness between 0.5 and 20µm can be handled by a precise winding system. The process can easily be controlled to deposit metal layers up to 60nm, so finished metallized films might achieve resistivity values of below 1.5 Ohms/sq. A specific winding system has to guide the very thin substrate through the process and to rewind it without damaging it (down to 0.5µm PET or 3µm BOPP).

The Heart of It: The Winding System

Vacuum web coating metallizers operate with a winding system consisting of separate drive units for the "unwinder," "coating drum," "tension roll," and "rewinder." Precisely regulating the web tension at the coating drum, without being influenced by the rewinder, requires separate traction between the coating drum and rewinder. This is accomplished with a tension roller. The rewinding quality is directly impacted by the contact of the substrate to the coating drum. There a variety of tools can be included to enhance this contact. The arrangement of guide rollers is also of importance because they have to minimize unguided distances of the substrate as far possible.

For handling and metallizing sensitive substrates like UTF PET (film thickness down to 0.5µm) and the upcoming down gauging of BOPP (<3.0µm is available), the drives of the winding system needed to be adapted. For the advanced vacuum web coating system, a specially designed winding system is offering capacitor film manufacturers a fast exchange of drive units. Using this feature, the web coating system is highly flexible and processes substrates from 0.5 to 20.0µm.

Development of Applied Films' patented segmented spreader roller (Figure 1) has provided a breakthrough in coating technology for handling UTF substrates, because it offers the process flexibility needed to handle a wide range of film coating applications. The system consists of several single idle metal rollers that spread the substrate being coated in such a way that it leaves the final roll flat and smooth without

Dielectric	Thickness	Resistivity	
		Al	Al/Zn
	[µm]	[Ω/□]	[Ω/□]
BOPP	<3.0-20.0	<1.5->30.0	<2.5->40.0
PET	(0.5), 0.7-12.0	<1.5->10.0	<2.5->10.0
PEN	1.4-6.0	<1.5->5.0	-
PPS	1.2-6.0	<2.5->5.0	-
PC	(1.5-9.0)	-	-
Paper	5.0-20.0	<5.0->40.0	<7.5->30.0

Table 1: Examples of Metallized Film Combinations

Figure 1: The Patented Spreader Roller for UTF

any additional stretching. In this way the film is adjusted without any overexpansion taking place. When positioned in front of additional process steps, such as masking, the spreader roller system improves the dimensional accuracy of the imaged stripes and patterns, eliminating the need for an additional idle roller. In addition, static charging is avoided because the whole winding system is metal.

The Coating Modules

The first capacitor materials were usually coated with a single aluminum (Al) layer. Ongoing development and changing demands for the capacitor industry resulted in further layer systems being deposited in one machine. Today, in addition to the

Figure 2: The Al UTF Coating Module

single aluminum layer, aluminum-zinc (Zn) mix coatings play an important role. Depending on the philosophy of the capacitor manufacturer, silver and/or Al can be used as preseeding for the Zn main layer. It's also possible to deposit other materials, such as copper, as an alternative but the most commonly used mixed layer is still an Al-Zn combination.

To offer focused solutions that meet the requirements in the best and most economical way, the web coating system has been developed as a modular system concept (Figure 2). Depending on the process required, different production modules can be used, which are quick to exchange:

- Standard aluminum (silver/copper) - zinc module (for mixed coatings)
- Aluminum high rate evaporator module (with Applied Films' patented staggered boat system for single aluminum coating)
- Further developed aluminum high rate module for UTF substrates.
- Combined module (for mixed aluminum, silver/copper-zinc coatings or normal rate single aluminum layer)

Masking Systems for Unmetallized Structures

In addition to the revolving, mechanical masking system between substrate and evaporator source, the new patented oil masking system, PatVap™, has become an accepted process module. Depending on the demands of the capacitor design, both systems are available with the advanced vacuum web coating system. The masking system is a significant technical milestone in the field of structuring deposited layers. During the oil masking process, a specific type of oil is evaporated, imaging the desired patterns on the substrate, which creates the thin film metal layer including corresponding insulating/fuse areas.

After the oil has been transferred to the substrate, it condenses in the specified positions on the film. During the metallizing process, the oil on the substrates' surface is vaporized by the energy from the metallizing process itself. This creates a localized protective gas cushion which inhibits the metallization in the defined local area on the film. With the advanced masking technology, accurately defined structures down to 0.1mm are creatable, even on UTF down to <1.5µm PET. The high accuracy of imaged structures is crucial for the reliable and proper function within thin film capacitor applications.

The applied oil layer has a thickness in the nanometer range and therefore can be transported over guide rollers without the oil image being smeared or separated. The quantity of the vaporized oil can be applied in such a way that almost no oil remains.

Combining precise pattern masking with the flexible coating modules for various electrode materials in dimensions required on UTF BOPP is

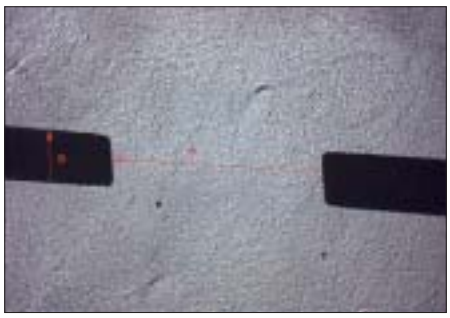


Figure 3: Example of a Pattern Made with the Inline Pattern Masking System PatVap™

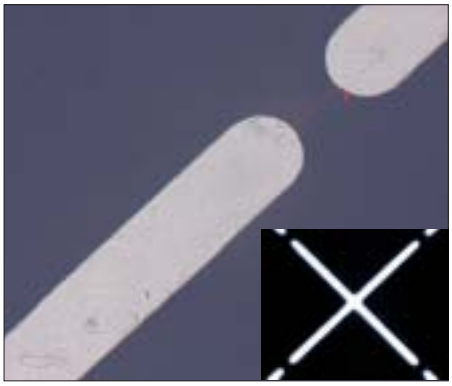


Figure 4: Example of a Pattern Made with Inline Pattern Masking System PatVap™

the key technology for demanding film capacitor applications. More and more, leading capacitor film metallizing companies, such as Korean SUNGMOON ELECTRONICS, are using metallizing systems equipped with PatVap™ to deposit pattern geometries on UTF.

Plasma Generated Web Charging/ Discharging

To increase coating speed at increasing layer thicknesses on down gauged and more sensitive substrates, plasma generated electron/ion sources can be used to improve substrate behavior on the coating drum during deposition. Figure 5 and Figure 6 show a charging/discharging solution for the capacitor film production system that can be operated

Figure 5: WEB Charging/Discahrging

Figure 6: WEB Charging/Discahrging

simply by adjusting voltage and gas flow at a higher background pressure of the winding chamber. It can be positioned at various places inside the system and easily be maintained without filament changing. Since it requires no additional pumping system and no complicated beam deflection system, no hot spots are created. With this system, Al layers with <1.5 Ohm/Sq. on UTF PET 1.4µm at web speed 8 meter/second can be deposited in stable conditions. It is also suitable for pattern metallization on BOPP 3.0µm with 15m/s (8-10 Ohm/Sq. Al/Zn).

Conclusion

Further exploitation of new electronic applications will require advanced thin film capacitors.

Metallized film capacitors are rapidly becoming an alternative to commonly produced capacitor types like Ceramics or Electrolytics.

New coating technology for capacitor design and production, like UTF handling for PET 0.7 to 0.9µm, various heavy edge combinations, and precise pattern masking on ultra thin film substrates (also BOPP <3.0µm), are already commercially available as an advanced thin film capacitor production system.

Capacitor manufacturers will profit from the expanding market for thin film and pattern metallized capacitors by using advanced vacuum web coating metallizers like the MULTIMET™, which meets these requirements. Some producers are already exploiting these innovations to produce high quality capacitors with advanced properties at reduced cost with a multifunctional and flexible system—offering production, design, and quality support for each user. ❑

Passives for Wind Turbine Installation

By Josef Reindl, Vishay ESTA
Theo van de Steeg, Vishay BCcomponents
Frans van Roemburg, Vishay BCcomponents

The adoption of renewable energy sources, such as the use of wind turbines, is advancing quickly as increases in oil prices are establishing price parity between power from renewables and fossil fuels. Additionally, there is a fast-growing, world-wide demand for energy, particularly in rapidly developing nations such as China and India. This demand is coinciding with the maturing of energy conversion technologies, which can now generate practical quantities of electrical power from the wind—in the range of several Megawatts per turbine.

The final pieces of the jigsaw puzzle are now falling into place. These pieces include techniques to ensure adequate power quality to drive domestic or industrial loads, Power Factor Correction (PFC) to avoid unnecessary reactive power loading of the transmission lines and network transformers, and increased efficiency of the power generation and transmission process.

Wind Turbine Configurations

A number of generator technologies, which lend themselves to particular modes of use, are currently operational. Large induction generators, for example, require no maintenance over long periods because they use no brushes. This makes them suitable for use in inaccessible locations, such as offshore wind farms. Power factor correction by separate capacitor banks is also essential to ensure best case unity power factor when connecting to the grid.

Using synchronous generators is another approach to converting the raw electricity generated at rotor speed to mains frequency, and to feed the rotor by DC link with large aluminum electrolytic capacitors, to smooth the DC-link voltages of the frequency converter. These typically have high voltage and current ratings, and therefore are physically large. They also have high ripple current capabilities in order to withstand load differences and perform reliably over a long lifetime in service. Capacitors such as the Vishay BCcomponents 102 series have been used successfully in such applications, assembled in capacitor bank configurations that frequently contain more than 100 capacitors in total. Experience has shown that all the capacitors within such a bank must display a similar rate of change in parameters over their lifetimes. Designers need to consider these capacitor banks as a whole, and ensure that all components are as similar as possible.

Wind turbines for use with such a power electronic converter are typically built without a gearbox, yielding a cost saving. However, in order to compensate for the sometimes large fluctuations in wind speed, the pitch of the turbine rotors is adjustable. Further motion controls, which make use of smaller aluminum capacitors for smoothing of power delivered to the pitch control rotors, are implemented to provide this.

Capacitor Design and Construction for Power Factor Correction

The requirements applicable to PFC circuits for use with wind turbines, based on the induction generator architecture—particularly those arising from wind speed fluctuations, heat build-up, overvoltage tolerance, and self-healing—demand capacitors that display a particular combination of characteristics.

Inrush Control Techniques

Continuously changing rotor speed means that capacitors are switched in and out of circuit much more frequently than in any conventional switched capacitor bank. Coiled wire inductors, the traditional established inrush control technology, generate excessive heat under these conditions. Integrated pre-resistors on the contactors, specially developed to suit capacitor switching, represent a better solution.

Package Design

Devices designed for wind turbine applications must ensure optimal can dimensions to maximize the ratio of surface area to volume, in order to maximize cooling. The arrangements of the winding elements play an important role in determining the shape of the can. Materials for filling the can are also of importance, in order to maximize the efficiency of heat transfer. Inert gas has become a popular choice, but the biodegradable, vegetable-based oil used in standard Vishay ESTA capacitors (designed specifically for PFC applications) displays around seven times better thermal conductivity. Because of their compact and slim design, ESTA capacitors also provide the best heat dissipation in the category of dry capacitors in gas design.

These measures to maximize heat transfer help typical life expectancy to exceed 150,000 hours, depending on how the ambient temperature and operating conditions influence the capacitor case temperature. Vishay ESTA PFC

capacitors have already shown their long term reliability in the wind turbine industry, in oil and dry design as well, for many years.

Countermeasures to Internal Fault and Overpressure

Unpredictable transients and harmonics, resulting from the motion of the rotor and resonance phenomena, may lead to repeated overvoltages and continuous self-healing processes, which will also increase the internal pressure within the capacitor. Techniques to combat this include all-phase overpressure tear off fuse systems, which have performed well in many applications for a number of years. These systems disconnect the faulty capacitor completely from the grid if the pressure inside the device reaches a level sufficient to expand the case, causing tear-off of the internal fuses. The active capacitor elements are thus cut off from the source of supply. The pressure within the casing separates the breaking point so rapidly that no harmful arc can occur. Self-healing properties are important in capacitors destined for wind turbine applications.

Cabinet Design Guidelines

The layout of power conditioning cabinets has an appreciable effect on performance, efficiency, and longevity. For example, experience has shown that mounting capacitors near the top of the cabinet increases the risk of overheating. Therefore cabinets should be designed to mount the capacitors in the cooler air near the floor (Figure 1). In addition, special capacitor terminal designs make it easier to connect large capacitor banks for power factor
correction (Figure 2). These "feed through" terminals allow capacitors to be quickly "daisy-chained," connected by cables with up to 25mm2 cross-section or 50mm, depending on the type of can diameter. Vishay ESTA always provides the highest cross-sections capacity in each range.

Figure 1: Control and Switching Cabinet for Induction Generator Wind Turbine, Showing Capacitors Mounted in Lower Region to Minimize Heating

Figure 2: Capacitor Terminals for PFC Applications in Induction Generator Wind Turbines, Facilitating "Daisy Chaining" with Large Cross-section Cables.

Conclusion

Almost every aspect of power capacitor design, from the windings to the filling solution and the terminations, must be optimum for wind turbine applications. These, and future enhancements, will play an important part in ensuring ongoing quality and reliability in wind turbine installations of all types and sizes. ❑

Continued from page 4

coincide to a reasonable degree with primary and secondary intelligence. I explained, for example, how tantalum was mined in Australia; engineered in the USA, Germany, Japan, and China; manufactured into anodes in Japan, Thailand, USA, Germany, Portugal, Israel, and China; and consumed in computers, cell phones, automobiles, defense electronics, instrumentation, mining and oil well electronics, medical electronics, and telecom infrastructure designs. Regional consumption for this dielectric is well distributed between the USA, Europe, Japan, Korea, and China. Sales are made either through distributors (30% direct to OEMs, 25% through distributors, and 45% to EMS companies). I explained that design is still well distributed in the USA, Japan, Europe, Korea, and China, and that approved vendor lists are important, but lose value as production moves to EMS providers and into China for final assembly. I explained this in detail for each major dielectric and resistive element, but concentrated on tantalum because this (as well as MLCC) is where China lacks momentum. Chip resistor production is owned by China, and they know it, but it is apparent that the price war in picofarad and microfarad MLCC is taking its toll on the domestic Chinese MLCC vendors (Yageo, Walsin, Feng Hua).

Social Gathering of JEITA after Mr. Zogbi's Presentation

The major concern in China is how fast they can catch up to Japan in the development of high layer count MLCC. I explained that yield ratios are key to profitability as are the proper dispersion of slurries and electrodes in inks. Once again, the equation involves the vertical integration of capacitance to capitalize upon the price per microfarad, regardless of dielectric. The problem, of course, is that the leaders in high capacitance technology in Japan (Murata, TDK, Taiyo Yuden, Kyocera, Rohm) will constantly improve upon their capacitance values, and most importantly improve upon yield ratios in existing key capacitance values such as 4.7, 6.8, 10, 22, 33, 47, 100, and 220 microfarad. As their yield ratios improve, their costs to produce decline, and they become profitable more quickly—until Chinese and Korean vendors can match the technology and lower price through diversification of supply.

JEITA's Passive Component Panel with Mr. Zogbi of Paumanok

I further explained that they lack value-added and application-specific passive components, which will become increasingly important as the local space race in Asia heats up against Japan. Such successful and ambitious satellite and manned programs require advanced high frequency and high voltage capacitors, resistors, and inductors that are not apparent in China in any degree of quantity or quality. Thus, the true opportunity for the future of profitability is to expend a certain percent of resources, maybe 15%, upon the development of advanced parts with higher ASPs and higher margins. This may slow the development of high capacitance parts, but the profitability equation in that engagement involves high yield ratios, so Chinese companies should be focusing their efforts on high yield ratios in 1 to 10µF and expanding their product portfolios to include high temperature, high frequency, and high voltage passive components.

JEITA Tokyo

After I departed greater China, with many a material vendor in tow right to the security line at the airport, I flew to Tokyo. There I spent two hours traveling the ten blocks to the JEITA offices.

As I later explained to my gracious hosts at JEITA, the audience was among the most educated I had ever faced, and upon my discreet discussions with my translator I noted the glares. Once again these glares were dissuaded by my explanation of the vertical integration theory of market research that involves the study of raw material usage and supply through to production and consumption. My speech at JEITA was strictly focused upon MLCC, but I expanded it to include other dielectrics because, once again, an unexpected number of delegates attended at the last minute (another

lesson—bring twice as many handouts as required).

My good friend, Mr. Osada-san from Nippon Chemi-Con, moderated the meeting and he knows me well enough to know I like a good challenge. He was kind enough to prompt all in attendance to ask me questions.

The general sense of the questions was one of an impending technology race in the region between Japan and China. The passive component vendors in attendance noted that it was their focus, from the component level through to the finished assembly, that they are in a struggle for economic domination of the region. The United States and Europe had obviously become a sideshow to the real battle. This was observation was verified in the local papers where the Japanese seemed awestruck by the ability of the Chinese to successfully launch a 5-day manned flight mission.

Another interesting aside came up during the after-ceremony (which my friends in Japan know I enjoy so much). Japanese manufacturers complained about winning chip designs, only to have them replaced with through-hole versions when the final product was transferred to China. Nowhere is this more prevalent than with the flat panel display industry. This especially holds true for V-chip aluminum and DC film chip capacitors. Thus, what these two product markets are experiencing is a churn rate in volume, with no new large unit increases in V-chip or SMD film chip in the capacitor display business. The V-chip was designed to replace the radial design due to better performance and efficiency, but radial leaded demand remains steady as Chinese vendors opt for the lower cost, mass-produced radial leaded designs which are readily available throughout greater China. There was a noticeable upturn in revenue during this process, but it was slight. The upturn happened only because the Japanese OEM time to market had a high frequency rate, which caused a delay in production transfer business to China, and this resulted in "increasingly smaller" time periods in which to make money based on advanced surface mount technology.

CARTS Europe: Prague

By the time I flew through Bangkok and Holland and arrived in Prague I had earned a whole new sleep cycle—one I had never experienced before. This was the apparent effect of going back in time. I slept consistently from 5 P.M. to 4 A.M., and held all pertinent meetings

Continued on page 40

Polypropylene Capacitor Film Resin

By Franck Jacobs,
Borealis Polymers

Within five years' time the consumption of polypropylene for capacitor films almost doubled—from 60,000 to more than 100,000 ton/a (Figure 1). The main growth was in China, where the number of BOPP (Biaxial Oriented PolyPropylene) lines for capacitor film increased from 8 to 20 lines in that same period of time. The global manufacturing of thin BOPP capacitor film in 2005 is estimated at 65,000 tons.

With an average thickness of 7µm, this results in 9,000 km of film which can cover the total area of the USA.

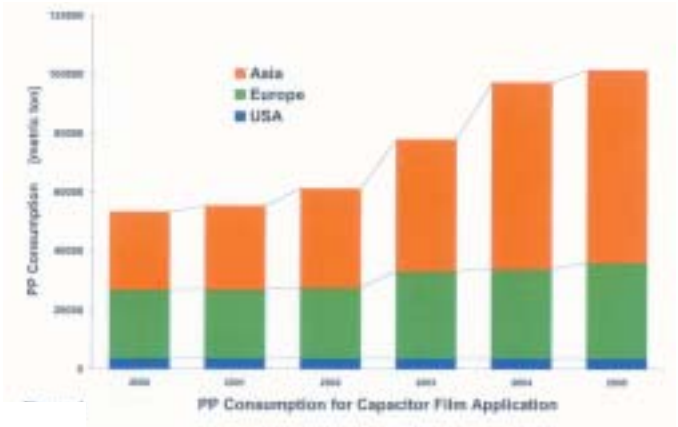


Figure 1: Global PP Consumption for Capacitor Film Application (2000–2005)

What Makes Polypropylene the Obvious Choice for AC Capacitors?

Polypropylene molecule chains lack any sort of polar groups that orient under electrical field stresses. Thanks to the absence of these polar groups, polypropylene intrinsically possesses a low loss factor and high volume resistivity. Combined with a relatively high dielectric constant, polypropylene, together with polyethyleneterephthalate, becomes the preferred choice of raw material for film capacitors (Table 1). When it comes to AC capacitor applications, polypropylene is the most suitable dielectric because the dielectric constant and low loss factor are largely independent of temperature and frequency.

The dielectric strength or break down voltage of the polypropylene film is increased considerably by a further biaxial orientation. This biaxial orientation of the film is obtained by stretching a heated sheet of film in two opposite directions, inducing a more perfect crystalline formation and orientation. In addition to the intrinsic dielectric properties, metallised BOPP films also posses the advantage

		Dissipation Factor	Dielectric Constant	Volume Resistivity	Dielectric Strength
		[#]	[#]	[log Ω cm]	[V/µm]
Polyethyleneterephthalate	PET	0.002	3.3	16	410
Polypropylene	PP	0.0002	2.3	16	380
Polystyrene	PS	0.0002	2.5	16	
Polycarbonate	PC	0.003	2.3	16	
Polyethylene	PE	0.001	2.3	16	

Table 1: Dielectric Properties of PP and PE

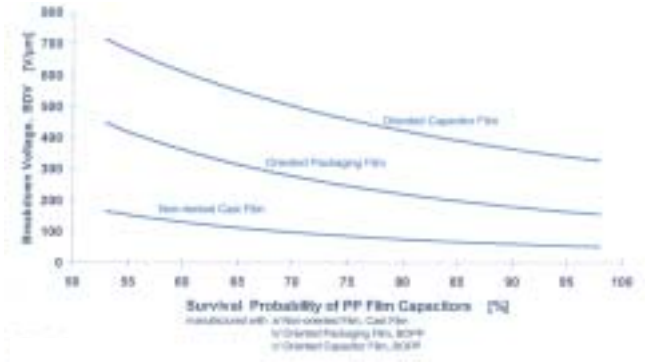


Figure 2: Survival Probability of Capacitors with Different Kinds of Films.

of self-healing by insulating the local short circuit due to a very occasional weak point or pin hole.

However, the high dielectric strength, volume resistivity, and low loss factor are only valid for pure and super clean polypropylenes. Unfortunately, most polypropylenes on the market—used for all kind of applications in automotive, building, packaging, textiles, and appliances—possess quite a lot of impurities originating from the polymerization process, from additivation or from contamination during the handling and transportation of the polymer.

Today there are only a few industrial polymerization processes in the world capable of manufacturing and marketing polypropylenes with the stringent and state-of-the-art purity for capacitor film applications.

Manufacturing of High Purity Polypropylene Capacitor Film

Polypropylene was discovered in 1954 by Dr G. Natta by the use of a catalyst type invented by Dr Ziegler. Commercial production of polypropylene began in 1957, with Hercules Incorporated, Montecatini, and Farbwerke Hoechst AG.

Polypropylene became one of the most important plastics, and was converted into a wide range of products such as textiles, pipes, automotive parts, appliances, and packaging materials. At the end of the seventies, the global polypropylene demand was less than 5,000 kton; meanwhile, 25 years later, this demand is almost tenfold, nearly 40,000 kton. With an expected annual growth of about 6 percent, it is—and has been—one of the fastest growing polymers over the years.

From these 40,000 kton not more than 100 kton is used for BOPP capacitor film production. The technology of polypropylene polymerization and the concurrent introduction of new catalyst systems have developed tremendously over the years and are still ongoing.

The fourth generation of catalyst systems is already a standard in today's manufacturing processes as bulk and gas-phase polymerization, while the first generation of catalysts, based on the concept of Ziegler-Natta, are fading and only in use today in a few plants, based on the so-called slurry process.

This conventional slurry process is nevertheless able to manufacture the purest polypropylenes, having a negligible ash content and catalytic residue of only a few ppms.

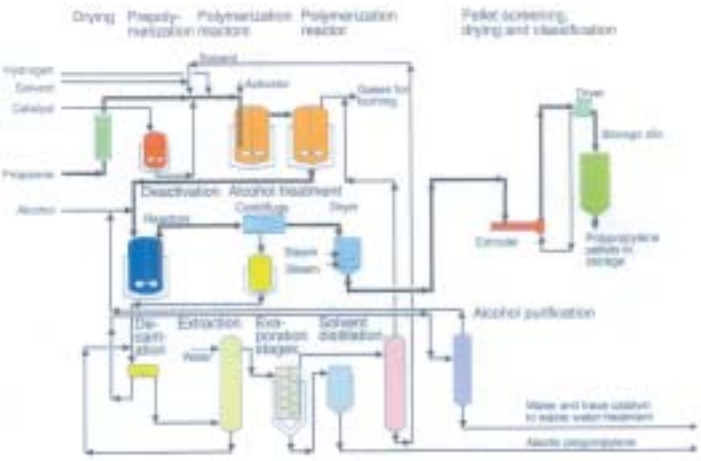


Figure 3: Polypropylene Slurry Process

The first generation catalysts, nowadays modified to a higher activity, are suitable for the slurry process (Figure 3). Due to the relatively low yield of these catalysts, the slurry process needs higher amounts of catalyst, resulting in an initial high amount of atactic propylene and catalytic residues. Adaptations in catalyst dosage, catalyst deactivation, and dissolving, followed by an improved organic washing and drying, ensures the low conductivity of the polymer. In the process incorporated purification section, this removes the residues by treating the polymer with an alcohol and a solvent that removes part of the atactic polypropylene.

The characteristics of the polypropylene itself can generally be summarized in the stereospecificity, molecular weight (Mw), and molecular weight distribution (MWD).

During the polymerization the propylene units (monomers) are joined together in a particular orientation (stereospecificity), to form a regular three-dimensional polymer chain of a certain length (Mw and MWD).

Using the modified preparation of the catalyst and an optimized process, Borealis offers today the highest purity homopolymer with extra high isotactic content and a tailor-made Mw and MWD. The increased isotacticity offers an enhanced crystallinity, resulting in higher heat resistance, better long-term dielectric properties at elevated temperatures, and improved mechanical film properties as modules and shrinkage. The tailor-made Mw and MWD enables converting the polymer to films with a thickness less than 3µm. ❑

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Designed for Tough Conditions—Large Size Aluminum Electrolytic Capacitors

By Norbert Will,
EPCOS, Automotive Applications Development

Because shock and vibration frequently lead to premature failures in motor vehicles, improved aluminum electrolytic capacitors of optimized design with significantly higher mechanical stability have been developed.

A shock and vibration resistance of 2 to 3g is sufficient for most automotive electronics applications. Many manufacturers of aluminum electrolytic capacitors quote a vibrational strength of 10g in their data sheets. At first glance, this figure seems to be quite sufficient with adequate reserves. But the test conditions under which this seemingly generous value was determined have little in common with real operating conditions: the tests last no longer than six hours, are conducted at room temperature, and the device under test is new.

In larger aluminum electrolytic capacitors with can diameters of more than 10mm, the wires with which the component is soldered to the circuit board repeatedly prove to be the weakest links despite reinforcement. The cross-section of the wire poses the greatest problem when vibrations occur. For this reason, EPCOS offers the thick, 1mm wire versions exclusively for all axial-lead capacitors targeted at automotive electronics. But this is not the only measure that enhances long-term stability. If aluminum electrolytic capacitors are operated over extended periods at elevated temperatures, the fixing of the winding in the can turns out to be the weak link in the presence of vibrations.

The winding anchorage weakens during continuous operation for two reasons. First, the mounting system, i.e. the aluminum can in combination with the cover disk, can buckle under the effect of high temperatures and the fixing forces, so that the winding is no longer held securely in place. Second, electrolyte diffuses from the mounted winding in the long term and the winding becomes softer, so that the bracing within the fixing system suffers accordingly.

The tensile or holding force of the classical axial bracing, for which a value of 10g is usually warranted, derives from the rather elastic region at the end of the winding (Figure 1). If the electrolyte content in this region is reduced, the holding forces will be correspondingly smaller. In an extreme case, the axial bracing can become ineffective. The welded joints between the winding and the feedthroughs, which are vital to operation and should be protected by the bracing, must then assure sufficiently high residual vibrational strength (Figure 1).

In general, the bulk of the winding reacts less sensitively to the loss of electrolyte because it is held in place by aluminum strips. The same applies to its diameter. EPCOS consequently fits an additional corrugation in the center of the can of all its axial-lead automotive series to give the winding radial stability.

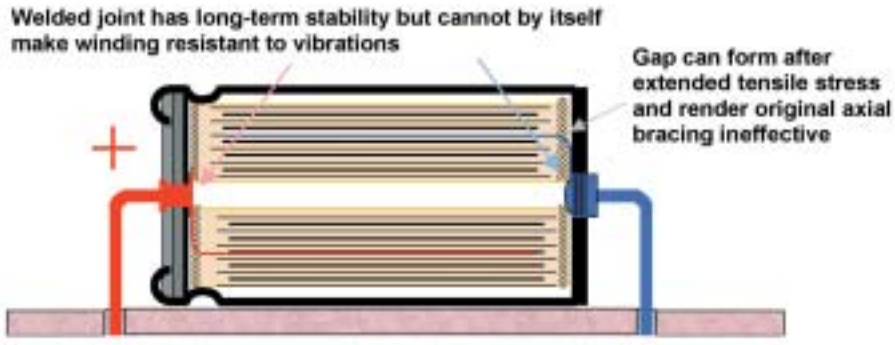

Figure 1: Basic Structure of Aluminum Electrolytic Capacitor

The warranted value of 20g obtained from tests on these axial-lead series is twice as high as that for the standard version. In the long term too, i.e. at the end of their operating life, these aluminum electrolytic capacitors rated at 20g still have significantly greater vibrational strength than the standard versions.

The normal radial bracing that suffices for axial electrolytic capacitors is not enough for the demands made on larger electrolytic capacitors with diameters of 22 to 35mm and heavy windings as mounted on automobile engines, for example. A special reinforced corrugation that does not buckle, even under high radial forces at high temperatures, is required. The corrugation shown in Figure 2 has proved effective in such cases. Thanks to its scarped flanks, it can protect the winding from stronger radial counterforces for the same material thickness without buckling.

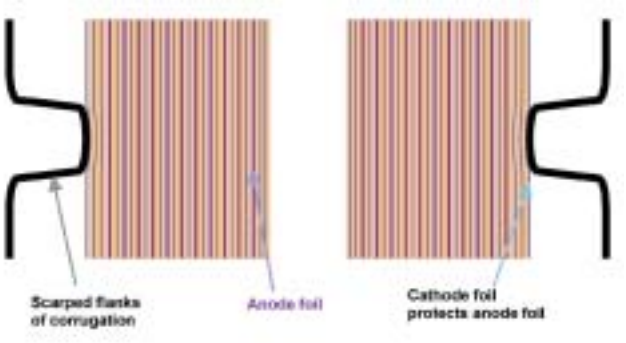

Figure 2: New Corrugation in Detail

In the parallelogram of forces, the bracing forces are transferred directly to the almost perpendicular corrugation wall without contributing to the large axial forces resulting with the classical flat corrugation. This also enables the new corrugation, used in the large size electrolytic capacitor series, to withstand greater radial bracing forces. This design has passed all vibration tests up to 40g and 2kHz. Even after the aluminum electrolytic capacitors were subjected to prolonged thermal pre-stressing for 2000 hours at 125°C, they passed a vibration test at 30g and up to 2kHz. The same applies to vibration tests performed after degradation by fast and slow temperature cycling. This corrugation (Figure 3) is currently used in all large size aluminum electrolytic capacitors intended for motor vehicles or machine tools.

Figure 3: Snap-in Electrolytic Capacitor with Additional Center Corrugation

Attachment of the aluminum electrolytic capacitor to the circuit board is just as critical. A new design was consequently developed from the original snap-in type. It can be bonded with wires that can be soldered and welded. The decisive factor is that the wires are flexible so that electrical contact is not interrupted even if the aluminum electrolytic capacitor moves relative to its mount (Figure 4). Both the soldered joint on the circuit board and the welded joint on the capacitor feedthrough are thus protected.

The exterior of the large size series is similar to that of single-ended capacitors. In contrast, their internal construction resembles that of a snap-in electrolytic capacitor with a flexible strip contact. Like all electrolytic capacitors with cover disks from EPCOS, this series also has fully welded contacts.

The new corrugation can also be used for the smaller aluminum electrolytic capacitors exposed to high vibrational stress, such as axial-lead and soldering star types. However, the standard corrugation has proved adequate for automotive applications up till now. We can nevertheless offer customers samples of existing types with the new corrugation added that can satisfy the tougher requirements concerning vibrational strength.

Tests have shown that the new corrugation design can be used independently of the can diameter. This means that large cans with screw terminals can also be manufactured with center corrugations in future. Initial attempts are in

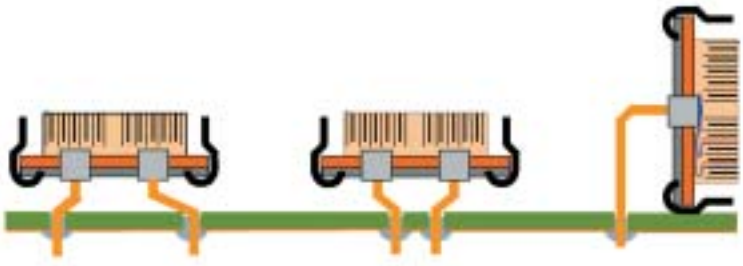

Figure 4: Improved Anchorage Ensures Higher Vibrational Strength

progress to fit aluminum electrolytic capacitors with additional new corrugations in order to keep improving the vibrational strength.

When the tensile force of the winding weakens toward the end of its useful life and the capacitor is exposed to vibration, a gap can form between winding and case. Then, if axial bracing buckles, the welded electrical connection alone cannot ensure the mechanical holding function during vibration.

Thanks to its scarped flanks, the new corrugation can protect the winding from stronger radial counterforces without buckling and with the same material thickness.

The snap-in models are complemented by the large size design in which wires instead of snap-in clamps are welded to the feedthroughs. This version is also available with customer-specific bent wires and without insulation.

Independent of alignment, the wires should be flexible so that any possible relative movements between circuit board and capacitor do not stress the soldered and welded joints. In contrast with the usual single-ended capacitors, the large size capacitor is insensitive to axial impacts applied to the feedthrough, thanks to the internal strip bonding. ❑

Technical Paper

Continued from page 15

and good self-healing characteristics are the basic requirements for capacitors for that filtering stage.

Output Filter

In order to protect the load after the inverter, capacitors in the output filter have to deal with voltage pulses with rapid voltage changes that lead to strong peak currents—it means high dV/dt-. Also the capacitors must protect the motor against high frequency components coming from the inverter. Consequently, high pulse handling capability, good AC performance, and good self-healing properties are required characteristics for these capacitors.

Snubber Capacitors

Snubber capacitors are connected in parallel with semiconductor components in order to damp high peaks of voltages that are provoked by their switching operation.

Again, high pulse handling capability and good thermal behavior means that low self-healing properties are requirements for these capacitors. In addition, good self-healing properties would further improve the protection level that any snubber capacitor could offer to the semiconductor, to overcome any other unexpected over-voltage.

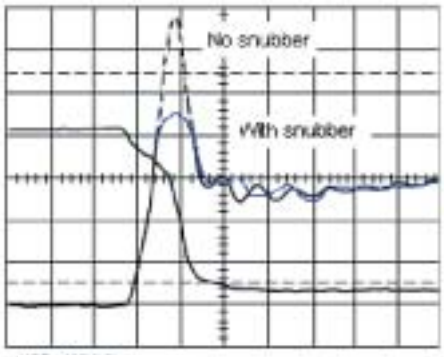

Figure 6: Snubber Capacitors

Finally, regarding the ambient conditions in this typical industrial application, 85˚C is the most usual figure for the maximum operating temperature. Only in some rare applications, under stringent environmental conditions, could the maximum temperature reach 100˚C. ❑

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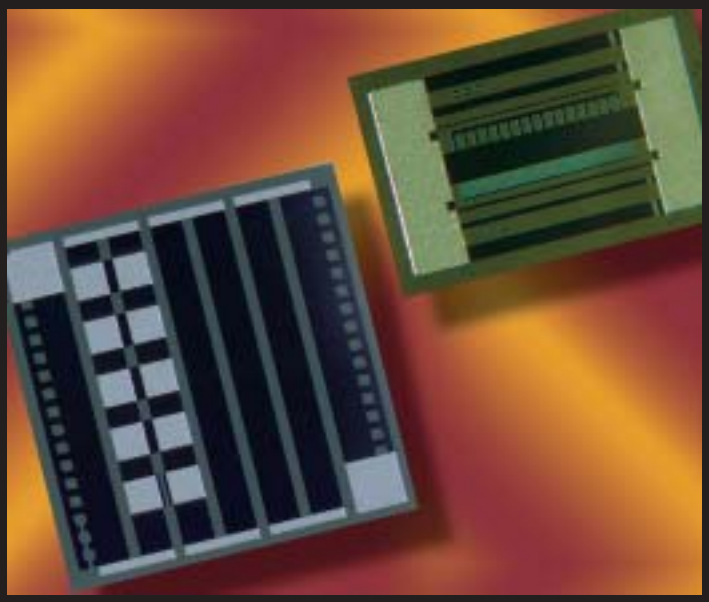

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Sample Listing

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YOURCOMPANY Inc. offers its new series of thin-film wire-bondable resistor chips featuring exceptional power handling in a compact design. Intended for power supplies and high-power circuits in amplifiers where increased power loads require a more specialized resistor, the new resistor chips come with available ratings of 500mW and 1W, respectively, in dimensions of 0.030in. x 0.045in. and 0.07in. x 0.07in. In addition to good power-handling capacity, the new resistor chips feature two large bonding pads that allow for greater design flexibility in compact hybrid circuits – and smaller end products – while providing room for Kelvin connections in low-value precision applications. YOURCOMPANY resistor chips are rated for 0.5W and are available in a resistance range of 0.3Ω to 1MΩ. The resistor chips have a power rating of 1W and are available in a resistance range of 0.3Ω to 2kΩ.
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Listings will be featured in the March/April 2006 issue of PCI Magazine

ECA Order Index Signals Strong Q4 Start

ARLINGTON, VA – The monthly order index compiled by the Electronic Components, Assemblies & Materials Association (ECA) began the fourth quarter on an up note, as October numbers continued the strong performance that began in July.

"We're seeing almost the exact opposite of what we witnessed last year at this time," reports ECA President Bob Willis. "In 2004, the end of summer marked a downturn; this year, the order index took a big jump in July and the upward momentum has continued."

The mood was optimistic at ECA's recent CARTS Asia and CARTS Europe events, according to Willis. Attendance at TAITRONICS, Asia's largest electronics show that hosted CARTS Asia, topped 65,000 during its five-day run, a 94 percent increase over 2004. "CARTS Asia and CARTS Europe showed that the industry is in a good place now," says Willis. "Nobody is predicting a boom, but strong worldwide growth is expected, with a few normal regional fluctuations."
Web: ecaus.org

KEMET Planning to Acquire EPCOS' Tantalum Capacitor Business Unit

GREENVILLE, SC – KEMET Corporation has announced that the Company is in advanced discussions with EPCOS AG with respect to acquiring the Tantalum Capacitor Business Unit of EPCOS. With KEMET's strong overall position in the tantalum capacitor market, this acquisition would further strengthen the company's ability to compete on a global basis. It would provide KEMET with increased access to certain key markets, including automotive and telecom, and would enhance the company's global manufacturing footprint. The combined manufacturing expertise of the two companies would result in an enhanced tantalum manufacturing platform incorporating the best elements from each. KEMET would then be better positioned to meet the increasing demands of the growing tantalum polymer capacitor market.

The potential transaction is subject to completion of definitive documentation, as well as completion of customary due diligence. KEMET anticipates that the final purchase agreement will be subject to customary closing conditions, including the receipt of all required regulatory approvals. If final terms are reached, KEMET would expect the transaction to be completed in the early part of 2006.
Web: www.kemet.com

Inco Launches Friendly Takeover Offer to Accquire Falconbridge

TORONTO, CANADA – Inco Limited and Falconbridge Limited announced today that their respective Boards of Directors have approved the acquisition of all the outstanding common shares of Falconbridge by Inco by way of a friendly takeover bid. The combined organization, which will be known as Inco Limited, will be one of the world's premier mining and metals companies in both nickel and copper, with one of the mining industry's most attractive portfolios of low-cost, profitable growth projects.

"We're bringing together two great companies, with excellent assets, to create a great Canadian player in the global markets," said Scott M. Hand, Chairman and CEO of Inco Limited, who will continue to serve in that role following the acquisition. "This combination will create a mining and metals powerhouse, with outstanding growth prospects and a truly unique opportunity to create significant value for shareholders going forward."
Web: www.inco.com ❑

In the Next Issue

Passive Components in Automotive

If interested in submitting an article, contact Mitch Demsko by December 30, 2005 at mitch@paumanokgroup.com or call (919) 468-0384

The Latest in Product Release News from the Passive Component Marketplace

New Tantamount® Capacitors Are Suited for a Broad Range of End Systems

Vishay Intertechnology, Inc. announces the release of new TR3 series molded tantalum chip capacitors that provide high efficiency with ESR values down to 0.035 and maximum ripple current values up to 2.07A (100kHz, 470µF).

Low ESR values allow for more efficient filtering in DC-to-DC conversion applications, while the devices' ability to handle high currents is key in microprocessor bulk energy storage applications. The new Vishay Sprague TR3 capacitors are intended for applications in telecom, automotive, computer, industrial, commercial, medical, and avionics end systems.

In addition to providing very low ESR values and a high ripple current handling capability, the new tantalum capacitors feature a proven solid tantalum construction that ensures long-term reliability. Outstanding stability over time and temperature further enhances the TR3 devices' performance and reliability.

TR3 devices are available in five molded case sizes (A, B, C, D, and E) with 100 percent tin terminations (RoHS-compliant), or 90/10Sn/Pb terminations upon request. Devices in the B, C, D, and E case sizes are 100 percent surge-current-tested. All TR3 capacitors meet EIA 535BAAE and IEC QC300801/US0001 specifications. The capacitors' compatibility with high-volume pick-and-place equipment simplifies assembly.

Capacitance values for TR3 tantalum chip capacitors range from 0.47 to 680µF with standard capacitance tolerances of 10 and 20%. Voltage ratings range from 4 to 50WVDC. The operating temperature range for the new devices is -55 to +85°C, or +125°C with voltage derating.

Samples and production quantities of the new TR3 molded tantalum chip capacitors are available now, with lead times of four to six weeks for larger orders. Pricing for U.S. delivery in 10,000-piece quantities ranges from $0.08 to $1.00, depending on case size.
Web: www.vishay.com

Clean Shave for Caps in Space

The latest designs of surface mount chip capacitors available from leading UK passive component manufacturer, Syfer Technology, can now be supplied with traditional tin/lead terminations. The devices are destined for equipment in specific industry sectors, including military/aerospace, space, and automotive, that are currently exempt from the RoHS directive.

The RoHS directive is designed to restrict the use of certain materials, including lead, which can be dangerous to the environment. While most industries are finding few difficulties in complying with RoHS requirements, certain sectors are exempt pending the investigation of a number of technical issues. In particular, equipment manufacturers are concerned about the possibility of tin whiskers which can cause a short-circuit in a component or on a board. The consequences could be disastrous for safety-critical applications.

Further, because of the mainstream move towards RoHS compliant components, the supply base for capacitors with tin/lead terminations is dwindling rapidly. Syfer, too, is committed to providing components that meet the RoHS requirements, and already has an extensive range of devices available. The company has a strong environmental policy, and its manufacturing operation is already fully approved to ISO 14001, the environmental standard. However, Syfer also recognizes that certain applications will continue to require a tin/lead finish, and the company has undertaken to continue to meet this demand.

In fact, Syfer offers the tin/lead finish, with a minimum 10% lead, across a wide range of multilayer ceramic chip capacitors. Devices can be supplied with either a standard silver or a FlexiCap base coat, both with a nickel barrier and the tin/lead finish.

Multilayer ceramic chip capacitors from Syfer are available in a wide range of capacitances, from 0.47 to 82µF and operating voltages from 16Vdc to 10kVdc, to suit a variety of low or high voltage/current applications.
Web: www.syfer.com

KEMET Announces New High Grade COTS T497 Tantalum Surface Mount Series Capacitors

KEMET Corporation announces the introduction of a new High Grade COTS T497 Series of surge robust tantalum capacitors. The new part types are available in nonstandard case sizes corresponding to the Military CWR09, 19, and 29 styles. The T497 COTS capacitors range from 0.10 to 150µF and 4 to 25volts. This series fits a demand for extended safety considerations. The T497 series offers many unique options that allow users to customize the product to their specific application needs.

KEMET's T497 High Grade COTS are ideal for high-end industrial power supplies, military designs, portable communication systems, and other critical filtering and decoupling applications. This product is low profile (0.0500" height for case size A through D), which is compatible with PCMCIA type II applications. The T497 Series has been designed with very low leakage current, making it suitable for self-contained or depleting power source (battery) products. The T497 is offered with a COTS (Commercial Off the Shelf) option with special testing available: surge current, Weibull grading, and 100% X-ray. The T497 capacitors are available in RoHS compliant versions and in standard Sn/Pb (5% Pb minimum) terminations.
Web: www.kemet.com

Introducing the Guardian 6100 Plus Production Safety Analyzer with 20A Input Current Capability

QuadTech, Inc., introduces the new Guardian 6100 Plus Production Safety Analyzer. Six instruments in one, the 6100 Plus provides AC hipot, DC hipot, insulation resistance, ground bond, leakage current/functional run and open/short measurements from a single test connection.

The 6100 Plus joins the 6000 Plus as the industry's first safety analyzers with Twin-PortTM technology for simultaneous hipot and ground bond testing. It is possible to achieve dramatic time savings and increase product throughput by performing ground bond and hipot at the same time. You can fully automate the production line with CaptivATE Software and create a global database to archive data and print test reports on demand. Additionally, you can filter and plot test data to analyze historical trends, achieve paperless testing, and create electronic signatures for compliance with regulatory agencies.

Available by mid-November 2005, the Guardian 6100 Plus is priced at $9,895 and includes test leads, power entry adapter, corded product adapter for connecting to 115V products, and a NIST traceable calibration certificate. The 6100 Plus is TUV and UL approved, and carries the CE mark for wider acceptance in the global marketplace.
Web: www.quadtech.com/6100Plus

FFVE Capacitor Operating Conditions Increased for DC Filtering and Low Reactive Power Needs

AVX Corporation, a leading manufacturer of passive components, has increased the operating conditions of its medium power film capacitor family. Specifically designed for DC filtering and low reactive power needs, the FFVE is an alternative to electrolytic technology and is ideal for applications such as fuel cell converters, UPS, motor drives, and industrial power supplies.

The FFVE uses a non-impregnated metallized polypropylene or polyester dielectric, which features a controlled self-healing process, specially treated to have a very high dielectric strength in operating conditions. The capacitor has a capacitance range of 12 to 400 microfarads with a voltage range that extends to 1900 Vdc and an operating temperature up to 105˚C.

The FFVE now features high temperature and high voltage operating conditions, making the power film capacitor ideal for wind, solar and fuel cell converters, or even converters for next generation hybrid and fuel cell vehicles. The special design also gives the series very low stray inductance, and because the FFVE can withstand much higher levels of surge voltage, very high rms current, and has a longer lifetime, the FFVE is a very interesting alternative to electrolytic technologies. FFVE Capacitors meet the Level 2 requirement of the fire behavior standard: NF F 16-102.
Web: www.avx.com ❑

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TAITRONICS during its five-day run.

In the afternoon, sessions include Nick Baratte of JP Morgan Taiwan, on the Taiwan Version of Wall Street; Amy Wang of China Outlook Consulting, on electronic component distribution in mainland China; and Dennis Zogbi of Paumanok Publications, USA, discussing the global passive electronic components industry.

Wednesday, October 12

TAITRONICS: TEEMA President Cheng welcomes CARTS Asia attendees. Dr. Tomas Zednicek, AVX, Czech Republic, CARTS Asia 2005 Zandman Award recipient, opens the Materials and Processes session. Copper and nickel powders, ZnO, glass terminations, and RoHS compliance dominate the discussions.

In the afternoon, Dr. Rudolf Huenert, ECKA Granulate MicroMet GmbH, Germany, leads the applications track. Tantalum, aluminum, niobium, MLCC, silver nano, X7R, and other subjects are discussed.

This is another day filled with information:

- In 2004, Taiwan exported more than NT$2.77 trillion in electrical and electronics production compared to NT$1.79 trillion in imports, resulting in a surplus of NT$318 billion.
- Electronics surpassed the textile industry for the first time in earning the most foreign currency for Taiwan.

Taitronics, a Record Setting Attendance

In the evening, TEEMA and CARTS Asia 2005 sponsor a reception for TAITRONICS exhibitors and buyers. ECA thanks EIA members and CARTS Asia sponsors Cornell Dubilier, KEMET, and Vishay Intertechnology.

Thursday, October 13

TAITRONICS: CARTS Asia continues with design and construction sessions chaired by Prof. Munecazu Tocano, Meisei University, Japan. Camber and stress, low ERS, stable polymers, C/V-ESL-SMT, coating, cracks, and microstructure are included in the mix of papers from experts around the world. Interestingly, more than 125 companies from 20 different countries are participating in TAITRONICS.

On the TAITRONICS show floor, more than 1,270 manufacturers display their products. Asian buyers make up more than 42 percent of the attendees, followed by Europeans with 25 percent, and Americans with 18 percent.

In the afternoon, Dr. Quincy Chen, EPCOS, Hong Kong, leads discussions on reliability and testing that address tantalum polymers, ceramic reliability, and lead-free solders. During TAITRONICS, the so-called G-Plan (Green Plan) is launched to help Taiwanese companies bring their operations into conformity with the EU's WEEE and RoHS directives.

TAITRONICS continues for two more days, achieving a 94 percent increase in attendance over 2004. Congratulations to TEEMA and TAITRA; I hope to return in 2006.

Friday, October 14

TAIPEI: I'm off to the airport and a six-hour fall back in time as I proceed to Prague, Czech Republic, and CARTS Europe 2005.

Saturday, October 15

Prague, Czech Republic: Six time zones later and 20 degrees cooler, I see that Prague is a city that is still waking up to modern Western ways. Customs in Europe can be a bottleneck for shipments from the USA, and nobody works on the weekends. Electronic components technology seems out of place—except for the cell phones, which are everywhere.

Monday, October 17

Diplomat Hotel, site of CARTS Europe 2005: CARTS Europe 2005 seminars make it clear that lead-free and RoHS are not compatible. Green icons are becoming accepted international visuals, but the icons themselves come in many flavors. And what happens when the exceptions to the rules outnumber the rules themselves? What does "homogeneous" really mean? Despite all the confusion, WEEE, RoHS, and the July 2006 compliance deadline are all coming your way.

At the marketing seminar, Paumanok's Dennis Zogbi predicts the world market for capacitors by dielectric for the next three years, the market shares of inductors in 2004, and the number of camera phones expected in 2010. CARTS Europe 2005 was the place to gather this information. By the way, there will be an estimated 630 million camera phones in 2010.

Tuesday, October 18

CARTS Europe 2005: Yuri Pozdeev Freeman, formerly of Vishay Sprague, now with KEMET, receives the Per-Olof Fagerholt Award for Best Paper in 2004 for his work titled "How Far Can We Go with High CV Ta Capacitors?" It's available now in the Digital Library on the ECA Web site, along with individual papers from many of the ECA conferences:
www.ec-central.org/marketplace/digital_store/entrypage.cfm.

Later in the day, Dr. Tomas Zednicek, AVX, returns to

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at 6:30 A.M. or later. This worked quite well.

In Prague the most important issues discussed centered on the frustrating RoHS compliance. This episode in the saga had a superb panel of experts including a government representative who was involved in the RoHS legislation. I had fun with him, describing in detail how tin burns at 11°C higher than lead (Pb), and that the increase in fossil fuel costs as well as energy costs makes those in compliance less competitive. Also, the fear arose that RoHS compliance testing would become a rapid growth industry that may be distributor driven.

The failure of Delphi held great weight as well. Automotive subassemblies account for 40% of European passive component sales in real dollars, and any American failures could have a ripple affect on other related auto assembly suppliers.

Personal Conclusions from the Trip

Price erosion in China for chip resistor and chip MLCC will continue, especially in the picofarad range. Matching Japanese multilayered technology in MLCC will take Chinese manufacturers a longer period of time than predicted.

Asia in general lacks value-added and application-specific passive component vendors to satisfy demand from the growing space race in the region. This lack may be a boon for American and European vendors of advanced parts.

RoHS compliance is the most fascinating experiment in protecting the consumer from toxicity related to lead. It is apparent that more coal will be burned to accomplish this goal, and higher fuel prices will make European vendors uncompetitive. It also opens up the possibility for compliance testing "boutique businesses" that will be costly and unnecessary. The government's argument in favor of RoHS compliance is the encouragement of member states to recycle, which in the grand scheme is a good idea. I was assured that the compliance issues would be reviewed by the EU every four years, and that changes would be made that reflect the real impact RoHS legislation has had on the environment. Let's hope this is so. ❑

Letter From ECA

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lead the session on the continuing saga of lead-free solders. After the sessions, there's a gathering of attendees within the exhibition area. Drinks and food are served, old colleagues welcomed, new acquaintances greeted, experiences shared, and memories made.

Wednesday, October 19

CARTS Europe 2005: Dr. Josef Sikula, Brno University of Technology, Czech Republic, and Ben Whittle, Dupont, UK, team to chair sessions that even a technologist's apprentice could learn from and enjoy.

Thursday, October 20

CARTS Europe 2005: Testing, reliability, materials, and processes are the topics of the day. These sessions, though similar to the sessions at CARTS Asia the preceding week, have a European bent. That's the nature of the CARTS series—international in scope but regional in presentation. Passive electronic component technologies are pretty much the same all over, but it's the application and end use processes that can differ from region to region. That's what keeps CARTS unique to its audiences.

At night, I take one last look at a city that holds its traditions very tightly but yearns to make its way in the new Europe. It seems to have found a happy medium for the present; we'll see how it fares in the future.

Friday, October 21

Ruzyne Airport (Prague International Airport): "I'm leaving on a jet plane, don't know when I'll be back again."

London Heathrow: Just passing through.

Washington, Reagan National Airport: Anybody seen my luggage? Delivery will be sometime tomorrow. Hey, I'm just glad to be back. I think I'll go have a cheeseburger in paradise, maybe drink an American beer, and watch a sporting event in real time. Seems like I never left. How many capacitors are in a beer anyhow? ❑

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Recently released technologies include OxiCap™ (niobium oxide) capacitors. These environmentally-friendly replacements for aluminum, tantalum polymer and high CV ceramic capacitors are fully compatible with the RoHS and WEEE directives. Another example of AVXs' continuous innovation drive, is the 0402 case size TACmicrochip™ which offers the Worlds' highest volumetric efficiency. This high reliability device is available in capacitance values from 0.47 - 10µF.

This year the Company increased production capacity of tantalum capacitors by around 15% and took output of the OxiCap™ family to over 1.5 Billion pieces, thereby providing the AVX advantage to an increasing number of applications.

AVX Advantages in Applications

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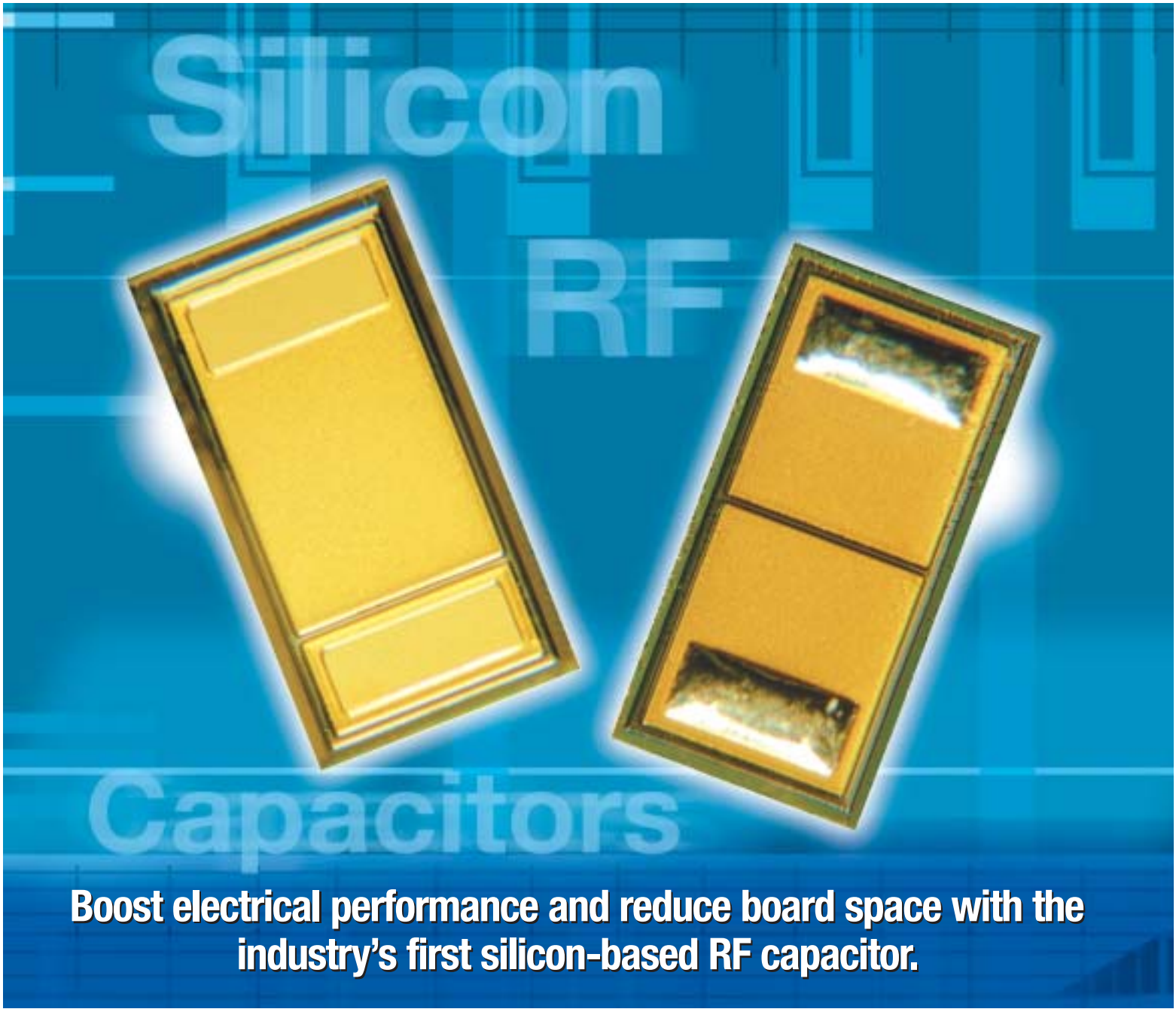

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