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(54) Title: SILICON CARBIDE BODIES

(57) Abstract

A self-bonded silicon carbide body produced by siliconising a preformed mixture of particles of carbon and silicon carbide in the beta form has a mean grain size in the range 0.1-5 microns. Such a silicon carbide body may be produced using silicon carbide particles having a mean surface area in the range 0.5-20 square metres per gram. The silicon carbide particles may be produced by heating a mixture of silica and silicon to generate silicon monoxide vapour and passing the vapour through a bed of particulate carbon.

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Silicon Carbide Bodies.

This invention relates to silicon carbide bodies and, in particular, to the production of bodies of self-bonded silicon carbide by reaction sintering of a preformed mixture of particles of silicon carbide and carbon in the presence of molten silicon. Such reaction sintering is hereinafter referred to as "siliconising" and one method of siliconising is described in UK Patent Specification No 1,180,918.

The present invention consists in a self-bonded silicon carbide body produced by siliconising a preformed mixture of particles of carbon and silicon carbide wherein the silicon carbide in the mixture is in the beta form and the silicon carbide in the body has a mean grain size in the range 0.1-5 microns.

The present invention also consists in a method of producing a self-bonded silicon carbide body by siliconising a preformed mixture of particles of carbon and silicon carbide in the beta form, the silicon carbide particles having a mean surface area in the range 0.5-20 square metres per gram, and in a self-bonded silicon carbide body so produced.

A self-bonded silicon carbide body in accordance with the invention, when compared with a self-bonded silicon carbide body produced using particles of alpha silicon carbide, has improved properties, in particular, in the extent and nature of deformation and microcracking around

indentations. For example in 500g load Knoop indentation tests cracking was much more localised and damage far less extensive. Also there is a greater dependence of hardness on load and may be higher hardness at low loads. These results indicate that bodies in accordance with the invention will behave in general in a more plastic manner, have less tendency to crack catastrophically and show greater wear resistance and surface toughness.

The coherent mixture of silicon carbide and carbon may be formed prior to siliconising by any convenient method such as extrusion, injection moulding, slip-casting or pressing.

The fine silicon carbide particles in beta form are preferably produced by passing silicon monoxide through a bed of particulate carbon which is converted to silicon carbide powder, the silicon monoxide vapour being generated by heating a mixture of silica and silicon separately from the bed of particulate carbon.

The following are examples of ways of carrying the invention into effect.

Example 1.

A mix containing carbon and beta-silicon carbide powders in the ratio 0.5:1 by weight, and sufficient polymeric binder to provide 42% porosity in the fully-consolidated body on removal of the binder, was formed into a cylindrical pellet by pressing at about 50 MN/m^2 with the exclusion of air. The silicon carbide powder had a surface

area of 3.7 m^2/g and the carbon powder consisted of crystallites which formed agglomerates with a surface area of about 6 m^2/g. The pellet was extruded through a profiled die to form components of uniform cross-section and the extrudate was cut and heated to 400°C to volatilise the binder. The 'green' material was then fired at 1650°C in the presence of molten silicon to convert it to a 90% dense silicon carbide containing 10% free silicon.

Example 2

A mix containing carbon and beta-silicon carbide powders, of the same size as in Example 1 but in the ratio 0.25:1 by weight, and sufficient polymeric binder to form a hard, rigid body on compaction, was pressed isostatically at about 100 MN/m^2 to form a component which was subsequently 'green machined', using a diamond tool. The 'green' material was heated to 400°C to volatilise the binder and was then fired at 1650°C in the presence of molten silicon to convert it to a 90% dense silicon carbide containing 10% free silicon.

Example 3

Beta silicon carbide powder, surface area 2 m^2/g, was mixed with carbon black, surface area 6 m^2/g, in the ratio 1:0.4 by weight. An aqueous slip was made up and a slip-cast slab was made. The slab was dried and siliconised at 1650°C for 2 hours in a vacuum of 1 torr. After cooling excess silicon was removed from the surface by abrasive blasting and the density of the slab was found to be

3.04g/cm^3 that is, it contained 19% by volume free silicon. The mean grain size in the slab was approximately 0.7 microns.

Example 4

Beta silicon carbide powder, surface area 4.4 m^2/g, was mixed with carbon black, surface area 6 m^2/g, in the ratio of 1:0.3. A slab was formed as in Example 3 and siliconised at 1600°C for 30 minutes. The density was 2.92 g/cm^3 (33% by volume free silicon) and the mean grain size was 0.5 microns.

Example 5

A beta silicon carbide powder, surface area 0.8 m^2/g, was mixed with graphite powder, surface area 60 m^2/g, in the ratio 1:0.4 by weight. Binder and lubricants were mixed in and rods 4 mm in diameter were extruded. After removal of the binder the rods were siliconised at 1650°C for 2 hours in a vacuum of 1 torr. Density of the rod was 3.12 g/m^2 (10% by volume free silicon) the mean grain size was about 5 microns and the Knoop hardness at 50g load was 3,650 hg/mm^2.

CLAIMS

1. A self-bonded silicon carbide body produced by siliconising a preformed mixture of particles of carbon and silicon carbide wherein the silicon carbide in the preformed mixture is in the beta form and the silicon carbide in the self-bonded silicon carbide body has a mean grain size in the range 0.1-5 microns.

2. A method of producing a self-bonded silicon carbide body by siliconising a preformed mixture of particles of carbon and silicon carbide in the beta form, the silicon carbide particles having a mean surface area in the range of 0.5-20 square metres per gram.

3. A method of producing a self-bonded silicon carbide body as claimed in claim 2 wherein the silicon carbide particles have a mean surface area less than 5 square metres per gram.

4. A method of producing a self-bonded silicon carbide body as claimed in claim 2 or claim 3 wherein the silicon carbide particles in the mixture are produced by passing through a bed of particulate carbon silicon monoxide vapour generated separately by heating a mixture of silicon and silica.

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 80/00182

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl.[3] C 04 B 35/56; C 01 B 31/36

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
Int.Cl.[3]	C 04 B 35/56; C 01 B 31/36

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [5]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category *	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	US, A, 4195049, published March 25, 1980 see claim 1; column 2, lines 27-37 and 55-60, J.E. Noakes	1-3
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	US, A, 4166841, published September 4, 1979 see claim 1; column 1, lines 7-14, J.E. Noakes	1-3
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	GB, A, 2017667, published October 10, 1979 see claims 1-8; page 2, lines 65-91, H. Suzuki	2-4
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A	Chemical Abstracts, Volume 88, no. 12, issued 1978, March 20 (Columbus, Ohio, US), see page 249, column 1, the abstract no. 78029c, SU, A, 585142, 25th December 1977, Podmoskovnyi Mining-Chemical Plant	1
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A	GB, A, 1180918, published February 11, 1970 see claims 1-9, Ukaea (cited in the application)	1
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* Special categories of cited documents: [15]

"A" document defining the general state of the art

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"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search [1]	Date of Mailing of this International Search Report [2]
29th June 1981	7th July 1981

International Searching Authority [1]	Signature of Authorized Officer [20]
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