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MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,
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[Continued on next page]

(54) Title: BORON CARBIDE BASED CERAMIC MATRIX COMPOSITES



C fibers

CVD carbon layer

Reaction
formed
SiC

(57) Abstract: The present invention is a composite material, a process and a product formed by the process. The composite is formed by a process that includes forming a fibrous structure comprising fibers into a preform, coating the fibers of the fibrous structure preform with elemental carbon to impregnate that preform, infiltrating the preform with boron carbide to form an impregnated green body. The impregnated green body is infiltrated with liquid naphthalene or other carbon precursor, which is thereafter pyrolyzed to form a carbon char. Then, the char infiltrated green body is infiltrated with molten silicon to form a continuous matrix throughout the composite. The silicon in the continuous matrix is reacted with the carbon char to form silicon carbide.

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**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations* AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, *ARIPO patent* (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), *Eurasian patent* (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), *European patent* (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), *OAPI patent* (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designations* AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID,

IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, *ARIPO patent* (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), *Eurasian patent* (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), *European patent* (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), *OAPI patent* (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

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B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02/28801 A (THE B.F.GOODRICH COMPANY) 11 April 2002 (2002-04-11)	1,2,4,5, 7-43
Y	pages 14-16; claims 1-10,12-17,28-44 pages 17-18 pages 21-23; figures 1-7	3,6
X	WO 98/24737 A (SAINT-GOBAIN INDUSTRIAL CERAMICS, INC) 11 June 1998 (1998-06-11)	1,2,4,5, 7-25, 30-43
Y	pages 9-13; claims 1-57 page 16, line 31 - page 17, line 25	3,6
X	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 12, 3 January 2001 (2001-01-03) & JP 2000 256064 A (NGK INSULATORS LTD), 19 September 2000 (2000-09-19) abstract	25,43
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	PATENT ABSTRACTS OF JAPAN vol. 017, no. 458 (C-1100), 20 August 1993 (1993-08-20) & JP 05 105868 A (TOSHIBA TUNGALOY CO LTD), 27 April 1993 (1993-04-27) abstract -----	14, 25, 26, 43

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US2004/016525

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
WO 0228801	A	11-04-2002	CA 2421032 A1	11-04-2002
			EP 1326813 A2	16-07-2003
			JP 2004510674 T	08-04-2004
			WO 0228801 A2	11-04-2002
			US 2004058154 A1	25-03-2004
			US 2004192534 A1	30-09-2004
WO 9824737	A	11-06-1998	US 5840221 A	24-11-1998
			AU 722864 B2	10-08-2000
			AU 5688498 A	29-06-1998
			BR 9714372 A	21-03-2000
			CA 2273100 A1	11-06-1998
			CN 1239468 A	22-12-1999
			DE 69728060 D1	15-04-2004
			DE 69728060 T2	11-11-2004
			EP 0946460 A1	06-10-1999
			JP 3483035 B2	06-01-2004
			JP 2001505522 T	24-04-2001
			RU 2176628 C2	10-12-2001
			TW 479074 B	11-03-2002
			WO 9824737 A1	11-06-1998
			US 6245424 B1	12-06-2001
			ZA 9710215 A	03-06-1998
JP 2000256064	A	19-09-2000	NONE	
JP 05105868	A	27-04-1993	NONE	