Non-Confidential Description - PSU No. 3972
"In-Situ Development of Novel, Graphene/Silicon Carbide Ceramic Composites, Methods for Manufacturing and their Applications"

Field of the Invention/Keywords:

Ceramics, Composites, hard materials, graphene

Links:

Inventor Achievement
Inventor website

Inventors:

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Background Of The Invention

Graphene, one of the strongest materials ever produced, possesses outstanding electronic and physico-chemical properties. Therefore, graphene sheets could be an ideal filler in the fabrication of robust ceramic composites. Graphene can be produced chemically or thermally, though its mechanical and conducting properties can be compromised under certain circumstances. Though expensive, the production of bulk graphene/ceramic nanocomposites is mainly done by mixing dispersions of graphene nanosheets and ceramic powders in solvents and subsequent densification at very high temperatures (1600-2000 ºC), which can degrade the graphene. The dispersion of graphene into the ceramic matrix highlights another challenge to the fabrication of homogenous graphene/ceramic composites. An unsuccessful dispersion will lead to the formation of graphene agglomerates and defects in the composite, causing a decrease in many beneficial properties of this material.

Invention Description

The subject invention represents a novel single-step process to make in situ graphene containing silicon carbide (SiC) matrix ceramic composites. Raman spectroscopy, FESEM and HRTEM observations confirmed the extensive graphene growth within the SiC matrix. This approach allows for processing dense, robust, highly electrical conducting, tough and well dispersed nanocomposites having a percolated graphene network, while potentially eliminating the handling of potentially hazardous nanostructures. Requiring pressures below 10 Pa, the process has fast heating and cooling rates (100 oC/min). The simplicity and speed of this process eliminates certain production costs, while improving yields. While demonstrating a range of physical strength between 300-1000 MPa for these novel, homogenous graphene/SiC nanocomposites, the electrical conductivity of the invention's graphene are as high as 1.02 x 102 S.m-1, which is nine orders of magnitude higher than the electrical conductivity of graphene free SiC ceramics with similar amount and type of sintering additives.

Commercial Applications

SiC ceramics exhibit excellent thermal and high temperature mechanical properties suitable for a wide range of structural applications (Roewer, 2010). The addition of graphene as filler further enhances those properties, including outstanding tribological and electrical performance. Graphene/SiC components could be used in technological applications under strong demanding conditions where good electrical, thermal, mechanical and/or tribological properties are required, such as micro and nanoelectromechanical systems (MEMS and NEMS), sensors, actuators, heat exchangers, breaks, components for engines, armours, cutting tools, microturbines or microrotors

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