CSIC, the Penn State University and the Shinshu University have developed a method for manufacturing in-situ graphene containing silicon carbide ceramic matrix composites in a single-step. The process can be easily transferred to a mass production and the developed components can be used in technological applications under electrical, mechanical and tribological demanding conditions.

Companies to develop and implement these materials are sought.

In-situ graphene/silicon carbide ceramic composites

Graphene, one of the strongest materials ever produced possesses outstanding electronic and physico-chemical properties. Therefore, graphene sheets could be ideal filler in the fabrication of robust ceramic composites.

The technology allows the manufacturing of graphene/SiC composites from a sole homogenous SiC starting powder, and in-situ synthesizing graphene within the ceramic matrix during the densification process using the spark plasma sintering technique. The process has fast heating and cooling rates (100°C/min), and vacuum pressures below 10 Pa.

Homogenous, dense, robust, highly electrical conducting, tough and well dispersed nanocomposites having a percolated graphene network are obtained. Raman spectroscopy, FESEM and HRTEM observations confirmed the extensive graphene growth within the SiC matrix.

Graphene/SiC composites present a range of physical strength between 300-1000 MPa, and an electrical conductivity as high as 102 S/m.

Graphene/SiC components could be used in technological applications under strong demanding working conditions where good electrical, thermal, mechanical and/or tribological properties are required, such as micro and nanoelectromechanical systems, sensors, actuators, heat exchangers, breaks, components for engines, cutting tools, microturbines or microrotors, etc.

Main features and advantages

- The simplicity and low time consuming of this process considerably reduces the production costs and improves yields compared to the mixing process of graphene and ceramic powders in liquid media.

- It also avoids the formation of graphene agglomerates and their degradation during the sintering process at high temperature, improving the reliability of the component under operating conditions. Besides, the proposed method greatly simplifies its transfer to a mass production.

- These composites extraordinarily increase the electrical conductivity (102 S/m) in more than 9 orders of magnitude compared to graphene free SiC ceramics with similar amount and type of sintering additives.

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