International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

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Alumina-Graphene Ceramic Nano-composites for Wear Resistance Applications

Overview

Advanced structural ceramics (such as alumina) and their composites are potential candidates for wear/impact resistant applications under demanding conditions. Graphene or few layers of graphene based nano-platelets are believed to be superior reinforcements to improve the physical, mechanical and tribological properties of the structural ceramics. Such conducting and superior toughening reinforcements acquire greater significance for applications under harsh service conditions. Recently researchers are showing interest in developing light weight composites using low density and high strength materials such as CNTs and graphene as reinforcing materials. Specifically, nano scaled atomically thin graphene produce smaller flaws in the matrix compared to conventional whiskers or fibres resulting improved strength and toughness. Since the graphene has very high surface area (e.g. single layer graphene - ~2630 m^2/g), 1 vol% of it would be sufficient to produce the maximum reinforcements compared to CNTs or similar reinforcement materials required to produce the equivalent properties. In addition, graphene also serves as solid lubricating material at micron and nano scales and reduces the frictional forces between contact surfaces.

Key Features

- Pressure-less inert gas sintering to achieve >99% of theoretical density
- Average Sintered Grain Size between 600 – 800 nm
- Homogeneous distribution of graphene
- Vickers Hardness at 10Kg load – 18.5 GPa
- Indentation Fracture Toughness – 5.0 MPa $m^{1/2}$
- Flexural Strength – 400 MPa

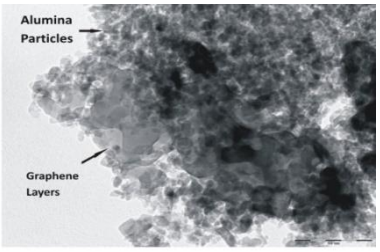

Figure 1: TEM image of alumina graphene composite powder

Potential Applications

- High Temperature Pump Seal Applications
- Wear Resistance components

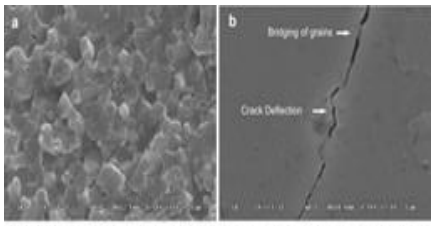

Figure 2: SEM image of fractured surface (2a) and crack propogation mechanism (2b) of sintered alumina graphene composite

Intellectual Property Development Indices (IPDI) 30%

- Performance and stability are validated at laboratory scale
- Scale-up and prototype module fabrication underway

Status	1	2	3	4	5	6	7	8	9	10

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