

## Graphene Enhances Alumina Ceramics Mechanical Properties by 50%

- Graphenea will exhibit its graphene products and G/Al<sub>2</sub>O<sub>3</sub> in nano tech 2014 in Tokyo (Spanish Pavilion- East Hall 5/Booth 5Q-17)
- Graphenea is a leading graphene producer, selling in more than 40 countries to research institutes, universities and industrial companies
- Graphenea collaborates in the development of new applications for graphene
- Graphenea, in collaboration with ITMA, has found promising results for advance ceramic industry

Graphene can reinforce ceramics, simultaneously making them conductive.

Graphenea found that when a bit of graphene is added to the ceramic alumina, the material becomes up to 50% less likely to break under strain, a feature highly desired for many end uses of ceramics. Furthermore, the method is simple, fast, and upscalable, making it virtually ready for industrial application. Graphenea believes that the same method could be used for reinforcing other ceramic materials, such as silicon carbide, silicon nitride, titania, and zirconia. What's more, the addition of graphene makes alumina a hundred million times more conductive to electricity.

### Graphene sheets are aligned along one spatial direction

Graphenea's new process, published in the Journal of the European Chemical Society, starts with graphene oxide, a commercially-available bottled graphene solution. After mixing with aluminium oxide (alumina), a process known as spark plasma sintering (SPS) is applied to homogenize the graphene/alumina mixture. SPS drives a large electrical current through the mixture, having the final product ready in minutes.

Graphenea found that the addition of as little as 0.22 percent of graphene to alumina made it 50 percent more resistant to the propagation of cracks under strain. Other mechanical properties stayed on par with untouched alumina, while electrical conductivity increased by a factor of a hundred million. Ceramics such as alumina are widely used in many industries, including aerospace, automotive, medical, thermal management, and semiconductor processing. The short propagation of cracks in ceramics is one of the most desired properties of this class of materials.

In words of Alba Centeno, the lead author of the paper, "the main advantage of graphene incorporation, at very low loadings, to an Al<sub>2</sub>O<sub>3</sub> matrix, is that graphene makes Al<sub>2</sub>O<sub>3</sub> electroconductive and, at the same time, improves mechanical properties and toughness. This is very important because sometimes when a second phase is incorporated in order to improve one specific property, the other properties are adversely affected."

A single graphene sheet bridges a crack in alumina, making the entire material more resistant. Graphene sheets in Graphenea's advanced material align perpendicular to the direction of the SPS current. The graphene sheets then act as shields, stopping any cracks that propagate along that direction. This novel approach could prove as a groundbreaking method of improving ceramic materials, and serve as a springboard for the mass use of graphene.

Graphenea is a leading graphene company that manufactures, produces and supplies graphene for industrial and research needs. The company has developed a synthesis and transfer process to obtain high uniformity monolayer graphene films on any substrate, over a large area. Other than high-quality large-area graphene on a variety of substrates, Graphenea markets graphene oxide and reduced graphene oxide in solution.

### Graphenea

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