Few-layers graphene-based cement composites

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Abstract

Cement composites are widely exploited materials worldwide, with a consumption of more than thirty billion tons per year and with continuous demand growth. [1]
The production processes for the Portland cement involve significant carbon emissions and consequently, it has a significant impact on the environment. [2] One possible solution to this environmental problem is to improve the mix-design to enhance the performance by the addition of special nano additives (*e.g.,* SiO_2 or TiO_2 nanoparticles).[3] The nano additives can increase the durability of cement composites, thus reducing future degradation and commercial demand. Moreover, they can add new properties and functions to the concrete *e.g.*, photocatalytic, electrothermal or self-sensing properties[4], thus transforming the cement composites into smart concretes. The carbon-based nano additives, graphene in particular, stand out among the wide variety of available nano additives. Nevertheless, the production of graphene is still a bottleneck for triggering the commercialisation of its cement composites. [5,6]
We exploit a high-pressure homogeniser, specifically the wet-jet milling, for the production of few-layers graphene at semi-industrial rates, *i.e.* kg per day (**Fig 1a**).[7] The high production rate enables the testing of new graphene-based cement composites, with the view of future commercialisation. The few layer graphene-based mortars produced (**Fig 1b**) demonstrated an improvement of the physical performances. In particular, we achieved an enhancement of ~25% for both the flexural and compressive strength.

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FIGURES

Figure 1: a) Examples of graphene dispersions produced by the wet-jet milling process. b) Raman mapping image of the fracture surface of a few layer graphene-based cement mortar sample.