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ISTITUTO ITALIANO DI TECNOLOGIA
GRAPHENE LABS

# FEW-LAYERS GRAPHENE-BASED CEMENT COMPOSITES

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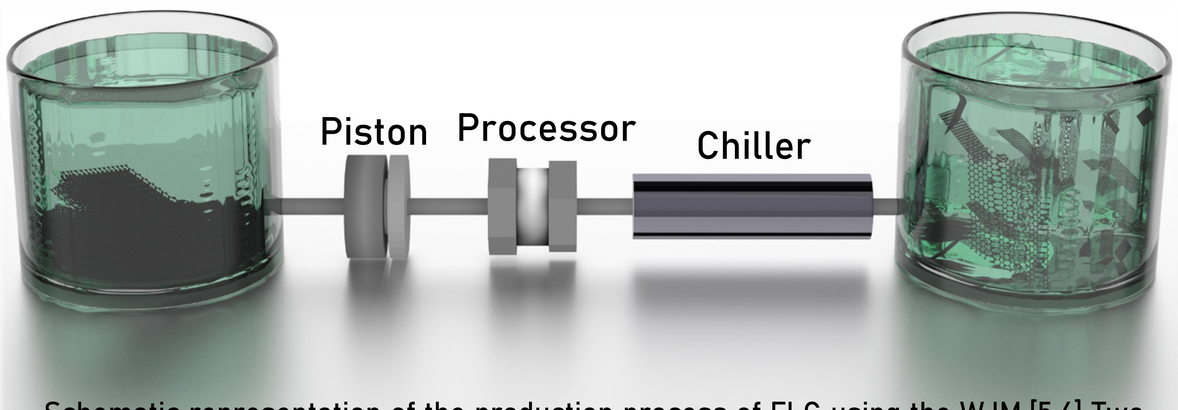
## Introduction

Graphene related materials can improve the physical performance, *i.e.* the mechanical properties, of cement composites.[1,2] The use of pristine graphene (without structural defects) remains as an un-explored route for the improvement of cement composites. In fact, the use of pristine graphene in cement composites has not been demonstrated yet mainly due to lack of a reliable scalable production of graphene.[3,4]
In this poster, we report the production of few-layers (FLG) and multi-layer (MLG) graphene at semi-industrial rates, *i.e.* kg per day, by means of the wet-jet milling (WJM).[5.6] The high-production achieved in the WJM enables the testing of graphene-based cement composites. The MLG-based mortars produced demonstrated an improvement of the ~25% for both the flexural and compressive strength.

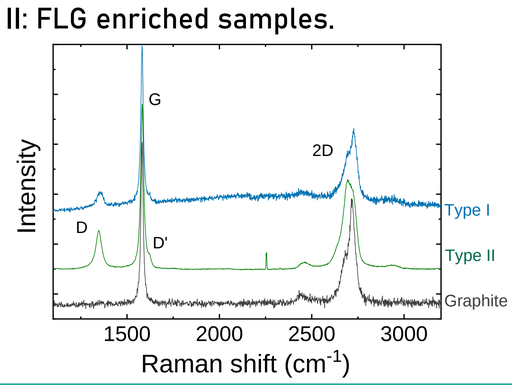
## Production of 2-D crystals

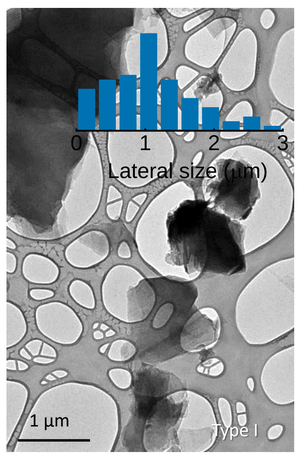


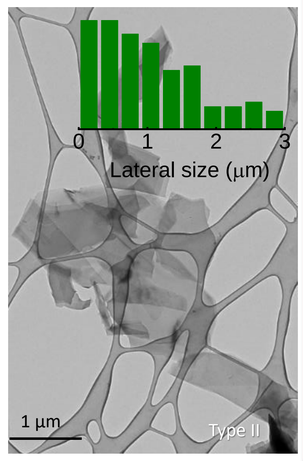

Schematic representation of the production process of FLG using the WJM.[5,6] Two types of samples are produced. Type I: MLG, and the Type II FLG.

## Graphene ink characterization

The characterization is performed by means of transmission electron microscopy and Raman. Demonstrating the presence of two different materials: Type I: MLG-enriched and Type II: FLG enriched samples.

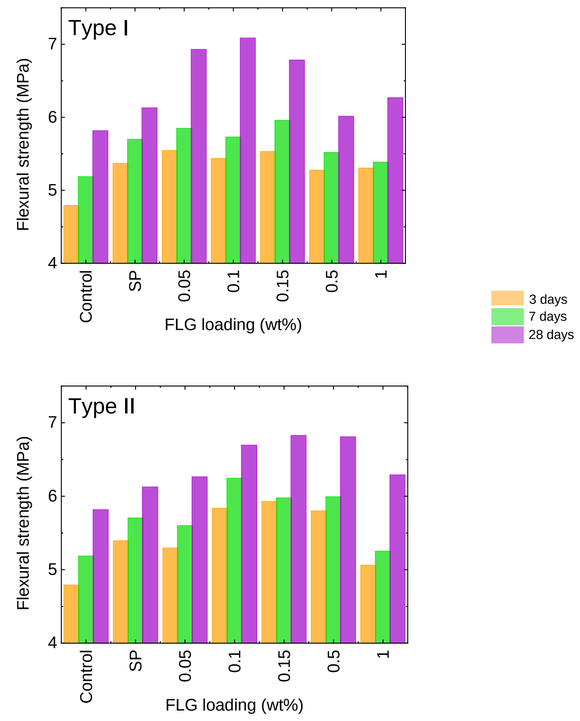


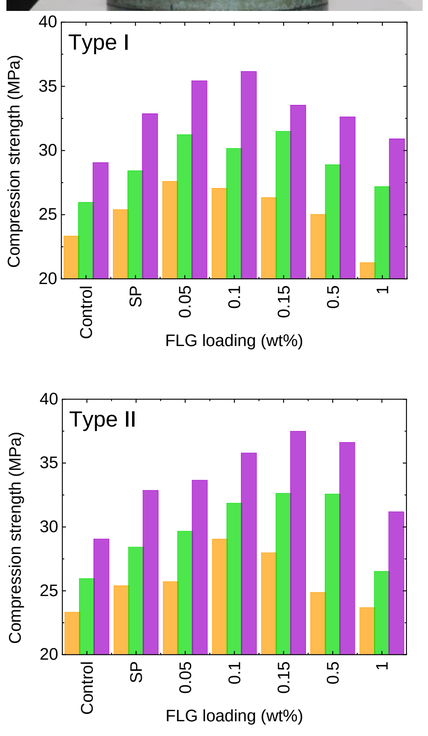




## Mechanical characterization

The compression and flexural test are carried out after 3, 7 and 28 days of curing, using different loadings of MLG and FLG. The best results were achieved using the Type II graphene samples with a FLG loading of 0.15 wt%, displaying an increase in maximum flexural and compressive strength of 25% and 29%, respectively.




3 days
7 days
28 days

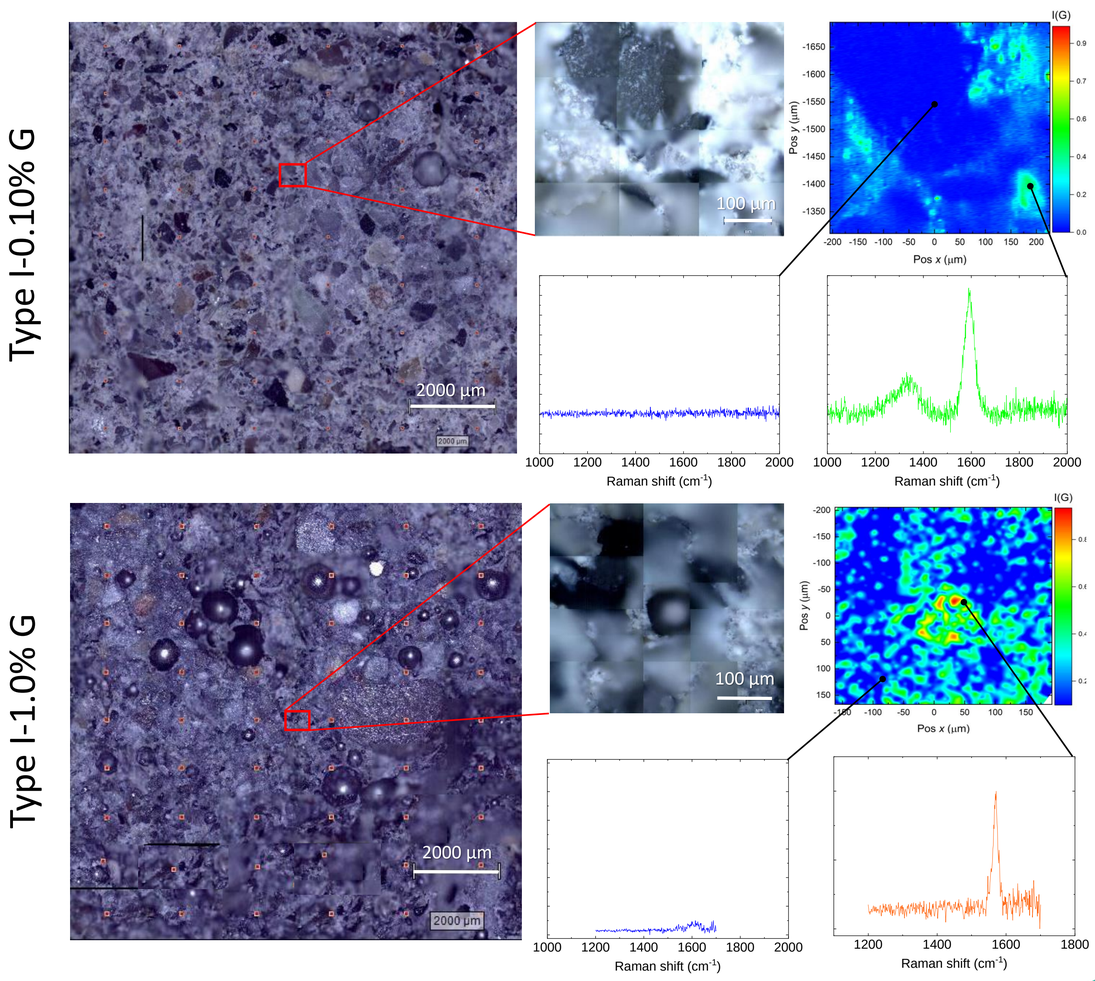






## MLG dispersion in the cement matrix

Raman spectroscopy is used to analyse the distribution of MLG flakes in the cement composites. The Raman mapping reveals that the MLG form clusters of graphene, and at large loadings (1%) the cement forms air bubbles, probably encapsulated in the MLG aggregates.




## Conclusions

- Few-Layer Graphene can be produced in aqueous dispersion using the WJM technique.
- A superplasticizer, commonly used in the construction industry, can be used as stabilizer.
- A FLG/MLG loading of 0.1% improves the mechanical performance of cement mortars. Conversely, larger quantities (1% by weight) of MLG determines the formation of air voids and clusters in the cement matrix that affect the mechanical behaviour.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