

Project Title: *Improve the mechanical properties of graphene and cement composite*

Supervisors: Wenhui Duan & Kai Gong
Email: *Wenhui.duan@monash.edu*
Phone: 03-99054958
Department: Department of Civil Engineering

Objective

The project aims to improve the mechanical properties of graphene and cement composite by optimizing the fabrication process.

Description

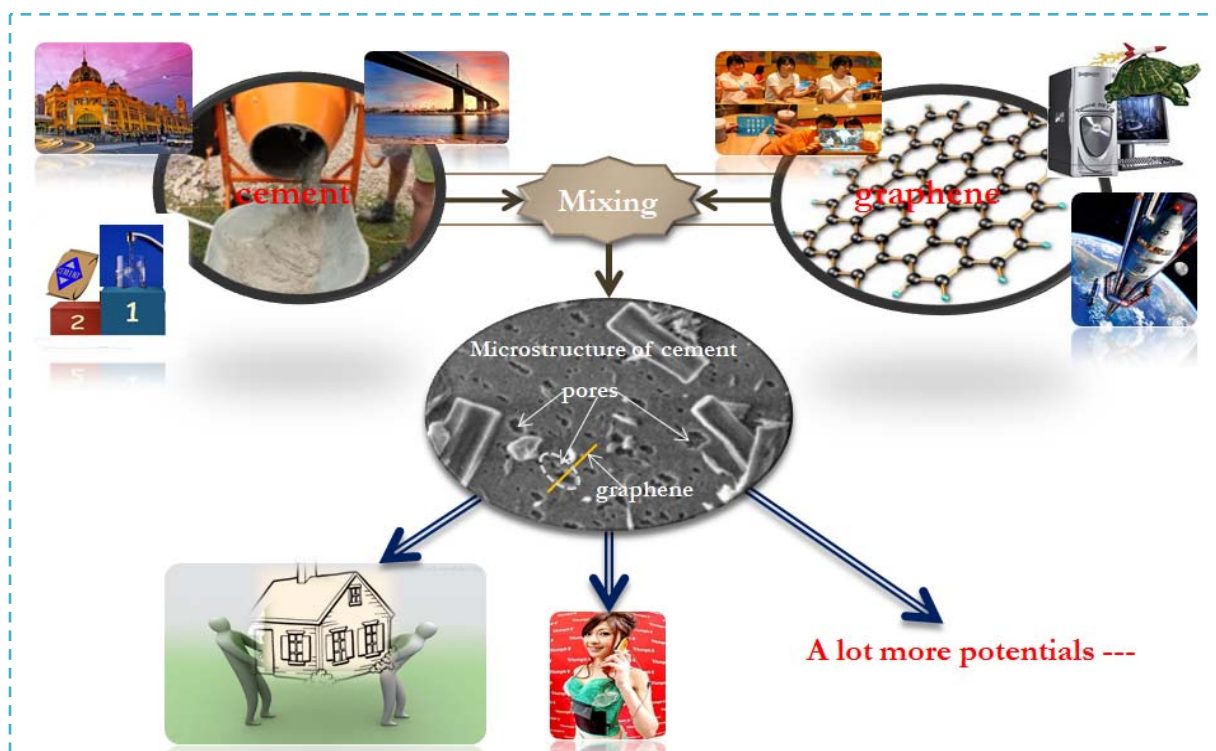


Figure 1, Schematic view of the overall big project. This summer research program only covers part of it.

Graphene-cement composite is promising new composite material that have great potential in various applications. It is produced by mixing graphene and cement homogenously.

What is graphene? Graphene is a single layer of graphite. If you slightly swept your pencil on a piece of paper, it is likely that you can get a few layers of graphene piled together. However, the first single layer of graphene was successfully synthesized only a few years ago by 2 physicists from university of Manchester. Because of their ground breaking discovery, they were awarded Nobel Prize of Physics in 2010. The best thing of this nano material is its vast, great potentials. For example, graphene is believed to have the potential to increase computer speed by hundreds of times, and make your laptop as thin and light as a piece of paper. More importantly, it is the strongest material ever tested. In fact, it is 300 times stronger than steel, this make it the only possible material to construct a space ladder to bridge our earth with other planet.

Cement, as you probably know, is universally used as construction material for all sorts of buildings and infrastructures. In fact, cement is the second most consumed material by human beings after water.

However, the largest weak point of cement is that it is very weak in tension because there are a lot of small pores in the micro structure as you can see in the figure. Those pores are the weak points. Now the idea of introducing graphene to cement is to bridge those weak pores in cement using graphene, the strongest material on earth, to provide reinforcing effects. Obviously, what we can expect is a huge increase of strength. Therefore, the ultimate goal is to create lighter and slender structures that have comparable or even higher strength.

More specifically for this project, the questions we are trying to address are:

1. Will the addition of graphene improve the strength of cement? Our preliminary results show YES.
2. How to improve the fabrication process to maximize the strength increment?
3. How graphene contribute to the strength increment?

Your job during the 12 weeks' Summer Research is to assist Kai Gong (my research student) to address Question 2. Addressing question 2 mainly involves experiments and some software modelling.

The project welcomes lively and creative candidates who have a strong math foundation from civil engineering, mechanical engineering, chemical engineering and materials engineering.

Significance: By creating slender and lighter structures, we are virtually using less material. Giving the fact that cement production is responsible for 2 billion tons of CO₂ emission every year, by using less material, we can reduce greenhouse gases emission enormously. There are a lot of other potential applications for this composite. For example, the new composite becomes smart material after introducing graphene as graphene presents superior electrical properties. This could be used to create sensors in road engineering. Also, it has the potential to produce wearable clothes that can generate electricity and charge your iPhone.