MONASH University
Engineering

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Theoretical investigation of nanoindentation response of graphene paper

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Graphene, a flat monolayer of carbon atoms packed in a 2D honeycomb lattice, is the strongest and stiffest 2D material (with the highest value of yield strength and the highest value of elastic modulus). The graphene research pioneers, Andre Geim and Konstantin Novoselov, jointly received the 2010's Nobel Prize in Physics. Research on graphitic materials has been actively carried out in recent years. In terms of the mechanical properties, nanoindentation test has been applied to measure the elastic modulus of highly ordered pyrolitic graphite (HOPG) and graphene paper. Graphene paper has the layered structure of graphene.

In a nanoindentation test, a diamond indenter is pressed into the surface of a specimen with the depths ranging from a few hundred nanometers to micrometers. The curve of the indentation force versus the indentation depth can be recorded, which can be used to extract the specimen's mechanical properties, such as Young's modulus and hardness. Due to its simplicity and convenience, nanoindentation test becomes a popular experimental method to study the mechanical behaviours of materials at small scale.

Graphene paper is transversely isotropic material. The reported measured indentation modulus is much lower than the theoretical prediction. In this summer research project, theoretical analysis and the finite element method will the applied to simulate nanoindentation tests on graphene paper. The objective of this study is to find the reasons behind the difference between the measured modulus and the theoretical modulus. The outcome from this research will assist us in understanding the mechanical properties of graphene paper. Through working on this project, the student will gain the knowledge on graphene material and nanoindentaton test and improve the skill on finite element simulations. The student should have a sound knowledge on solid mechanics or stress analysis and is interested in computational simulations.