MSc PROJECT PROPOSAL

3mE/PME & TNW
Micro and Nano Engineering (MNE) & Applied Nanophysics Lab

A Non-linear Identification Tool for Extracting Mechanical Properties of Graphene Sheets

BACKGROUND

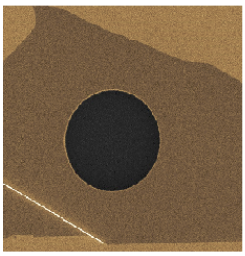
Synthesized by bottom-up processes, graphene is a carbon based nano structure with unique mechanical properties including low mass, high Young's modulus, high thermal conductivity, high surface area-to-volume ratio, and thus of great interest for MEMS/NEMS applications. The mechanical behavior of graphene sheets in these demanding applications is commonly studied by using equivalent continuum theories. The first issue in exploiting these theories is to find equivalent mechanical and geometrical parameters of graphene sheets. Non-linear System Identification (NSI) techniques are powerful tools that utilize experimental data to characterize structural behavior and are vastly used for estimating diverse parameters of macrostructures. The capability and exploitation of these techniques in obtaining the mechanical properties of nanostructures is still elusive. Therefore, this project aims at proposing a novel identification technique that could extract mechanical and geometrical properties of graphene sheets.

CHALLENGE / SCIENTIFIC QUESTION

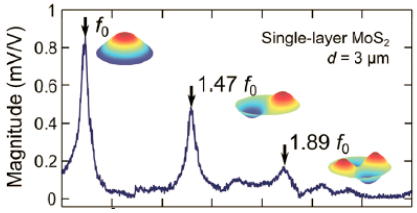
How can non-linear vibration testing be used to obtain the mechanical parameters (Poisson ratio, basal plane stiffness and damping characteristics) of suspended graphene sheets?

YOUR TASKS

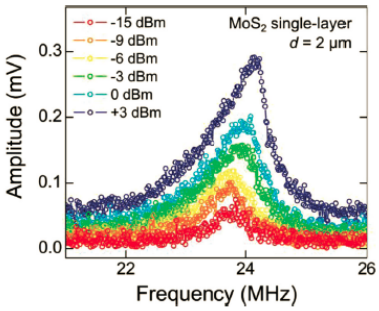
1. Fabricate graphene resonators and characterize their resonances.
2. Develop a model based on a continuum theory and perform non-linear linear vibration analysis.
3. Develop a new identification method to extract material properties and damping coefficient(s) of suspended graphene sheets by combining modelling and characterization results.



(a)SEM of Graphene resonator



(b) Linear Response



(c) Non-linear Response

OPPORTUNITIES

1. Work on an innovative multidisciplinary research topic. Collaborate with both 3ME and Applied Sciences (TNW) faculty groups, experiencing best of both worlds.
2. Gain expertise in non-linear identification and mathematical tools for numerical modeling of nano structures.
3. Fabricate and measure mechanical graphene resonators of sub-nm thickness at frequencies of 10-100 MHz.

REFERENCES

1. Castellanos-Gomez, Andres, et al. "Single-Layer MoS2 Mechanical Resonators." Advanced Materials 25.46 (2013): 6719-6723.
2. S. Lancaze, S. Missoum, F. Alijani, M. Amabili, Identification under Uncertainty of Material Properties of Composite Sandwich Panels. Proceedings of 29th Technical Conference of American Society of Composites, September 8-10, 2014, San Diego, USA.
3. R.J. Dolleman, D. Davidovikj, S.J. Cartamil-Bueno, H.S.J. van der Zant, P.G. Steeneken, Graphene Squeeze-Film Pressure Sensors, http://arxiv.org/abs/1510.06919

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