Atomic Force Microscopy's Characterization of Graphene Nanoplate and bubble

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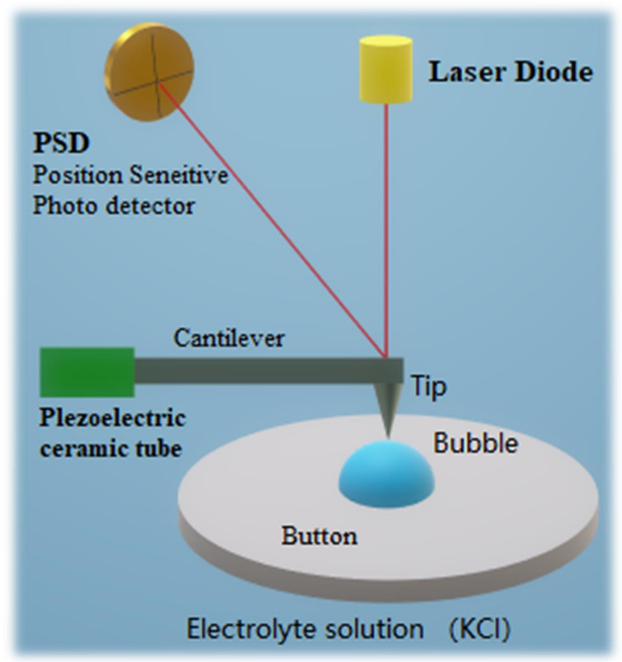
Introduction

- Atomic Force Microscopy(AFM) has been widely used since it was first invented in 1980s. Through a sharp tip scanned back and forth across a sample' surface, AFM determine the surface topology of nanomaterials with high resolution. There is also a static mode to analyze force-distance curves to get the corresponding mechanical properties.
- Tapping mode of AFM was adopted to scan the sample of graphene and Multi-wall Carbon Nanotube.
- The mechanical property of graphene– Young's Modulus, is calculated by in Hertz Model.



Methodology

☐ Methods:

1. **Graphene:**

Ultrasound 20-30 min in the solution of propyl alcohol and water, to get a well-dispersion solution of graphene nanoplates.

2. **Nanobubble:**

Bubble was generated by electrolyze of electrolyte solution(KCl, 0.1 M) and then was scanned on the surface of button battery directly.

☐ Principle of AFM:

The piezoelectric ceramic tube drives the AFM probe move in the vertical direction to maintain a constant interaction force between sample surface and AFM tip. The interaction force is detected by a laser reflected off the backside of the cantilever.

Results & Discussion

☐ Graphene Nanoplate:

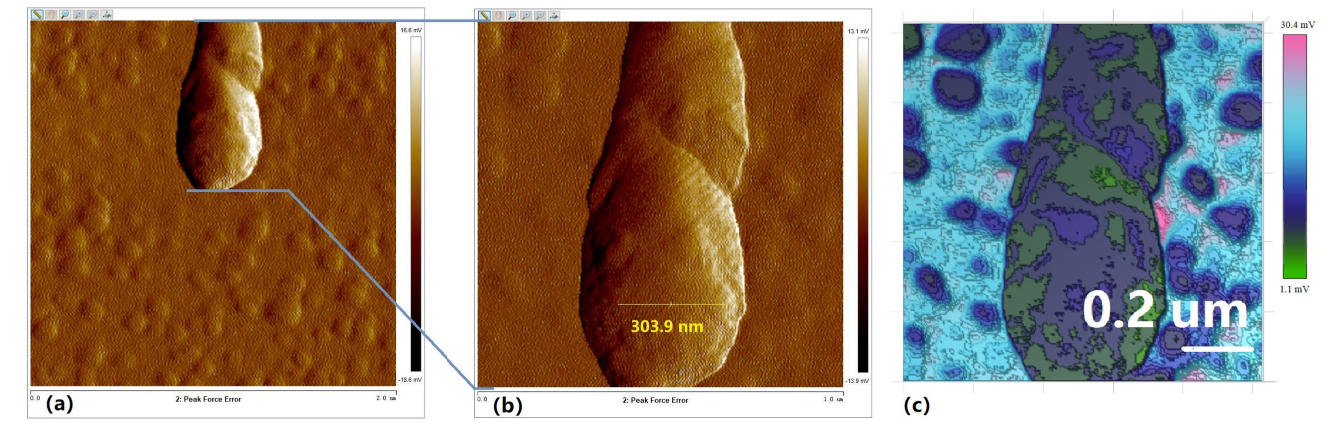


Fig. 1. The morphology of graphene nanoplate

☐ Multi-wall Carbon Nanotube:

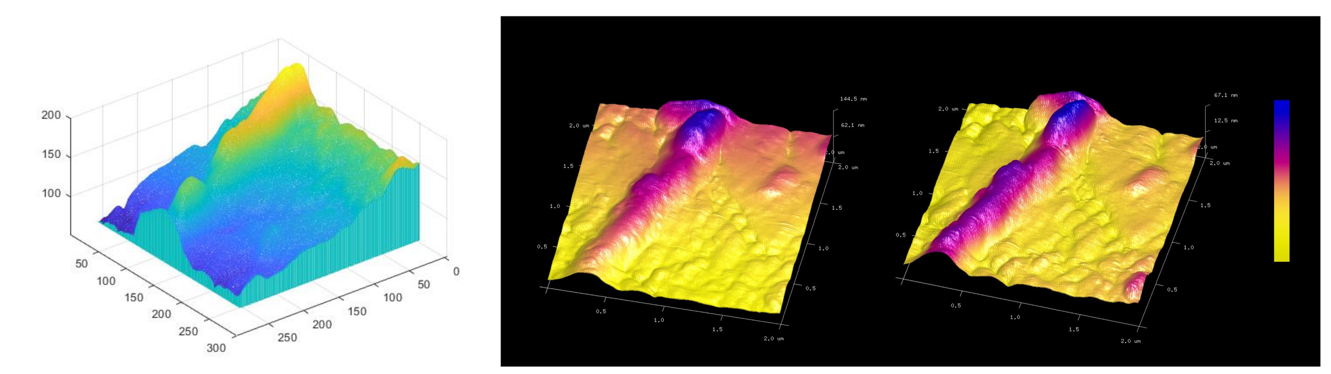


Fig. 2. The morphology of Carbon Nanotube by AFM

In this part, we perform the AFM characterization of Graphene Nanoplate and Carbon Nanotube, these two kind of nanomaterials have stacked-layer structure and tunnel-shape structure as shown in the figures respectively. The height results figure of Carbon Nanotube was plotted in MATLAB, as shown in **Figure. 2. (a)**.

☐ Nanobubble:

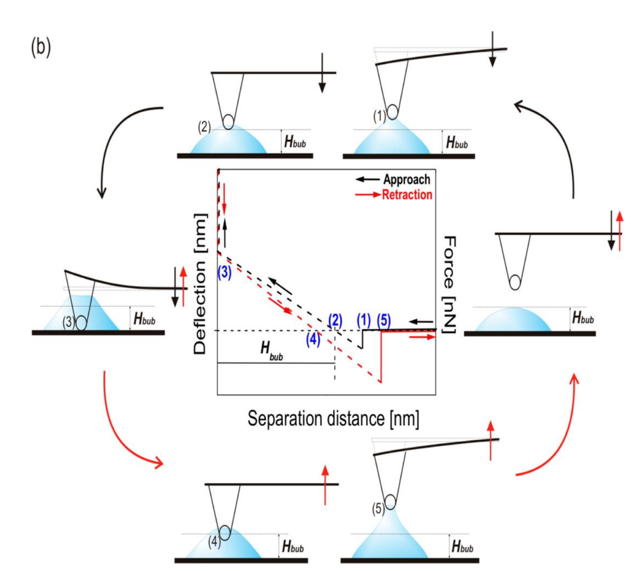


Fig. 3. Approach-reside-retract cycle

$$E = \frac{3(1-\nu^2)P}{4}\left(\frac{1}{R_i}+\frac{1}{R}\right)^{\frac{1}{2}} h^{-\frac{3}{2}}$$

- The bubbles were generated by electrical process, and AFM nanoindentation was performed under the liquid water.
- Hertz model was adopted to calculate the mechanical property of two spherical object. And the equation(left) can calculate the Young's Modulus.
- (Right) contact force-distance relationship of AFM's tip and nano-bubble. The MATLAB automatically deploy the 32*32 point of data, and integrate the data into the contour of nanobubble(bottom).

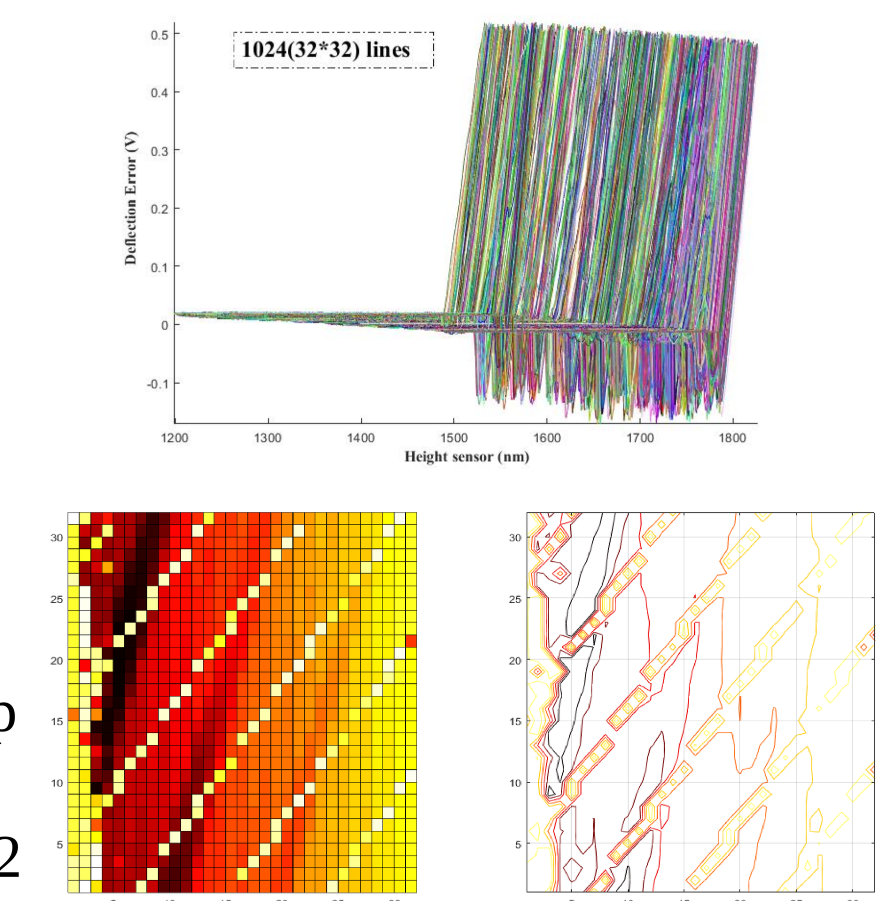


Fig. 4. (Up) 1024 contact line; (Bottom) Contour of nanobubble

Conclusion

- In this work, we get the basic information about Graphene Nanoplate and Multi-wall Carbon Nanotube, and those information includes the width distribution and the height of sample.
- Furthermore, the contact force and distance relationship has been obtained, and Young's Modulus could be calculated in the next step. More mechanical information about nanobubble would be reported in the future.

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