7.01 Roll-To-Roll Graphene Transfer

Transferring CVD Graphene onto Flexible Substrates by Hot Lamination and Electrochemical Delamination

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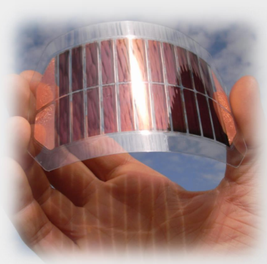
1. Goal and Applications:

→ Use graphene to make flexible, conductive and transparent electrodes

- Needed for optoelectronic and wearable applications, for example:

Smart Windows



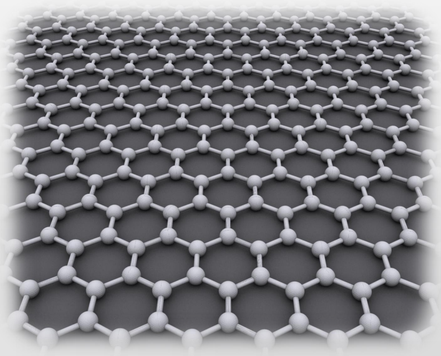
Solar Cells

Displays

Touch Screens

2. Background:

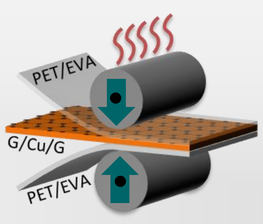
- Graphene is nearly *transparent*, ultra *strong* and has an extremely *high carrier mobility*
- This makes it a promising material to use as transparent conductive electrodes
- Large areas can only be synthesized by chemical vapor deposition (CVD) on Cu foil



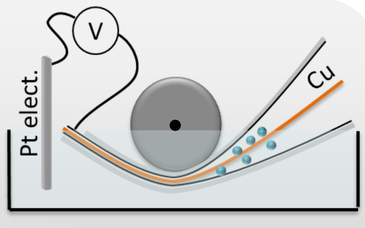
→ Challenge is to transfer graphene in a scalable way and with high quality

3. Approach:

- Use pressure and heat to laminate graphene to target
- Separate by hydrogen bubbles (use electrolysis)



Hot lamination



Electrochemical Delamination

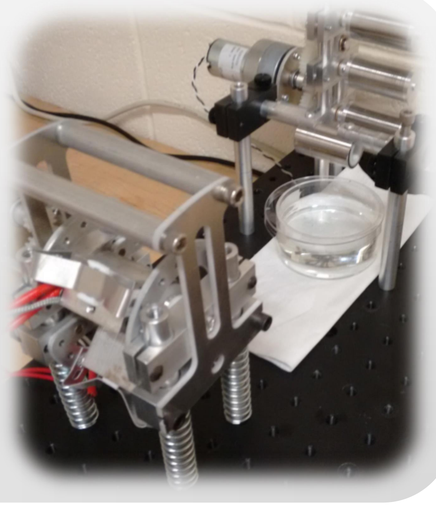
4. Implementation:

Lamination

- Use EVA coated PET as substrate
- Temp. range of heat shoes: **90° – 250° C**
- Speed range of DC motors: **0.7 – 5 mm/s**
- Roller pressure ranges from: **0 – 400 N**

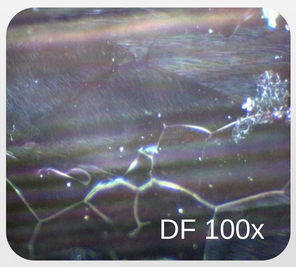
Delamination

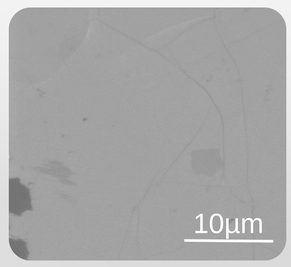
- Use sodium chloride (NaCl) or sodium hydroxide (NaOH) as electrolyte with 0.5 mol/l



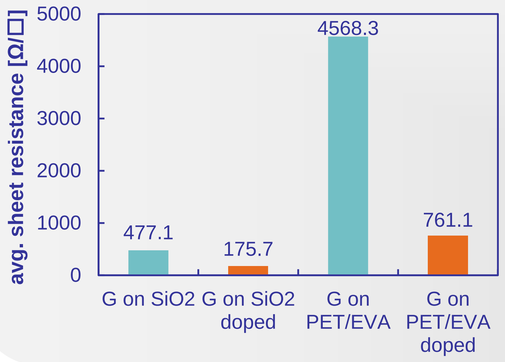
5. Metrology:

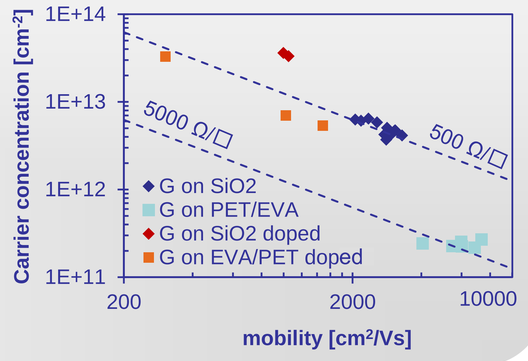
- Molding of copper foil texture highly visible on EVA
- Dark field microscopy (DF) helps to visualize features





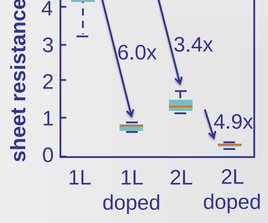
6. Electrical Characterization and Doping

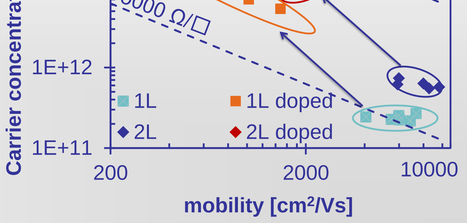




7. Repeated Lamination and Delamination

- Stacking 2 graphene layers improves conductivity by 3.4x
- This is more than expected increase of factor of 2x





8. Acknowledgement:

This project was funded by eni-MIT Solar Frontiers Center.