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Reducing Graphene-Metal Contact Resistance via Laser Nano-welding

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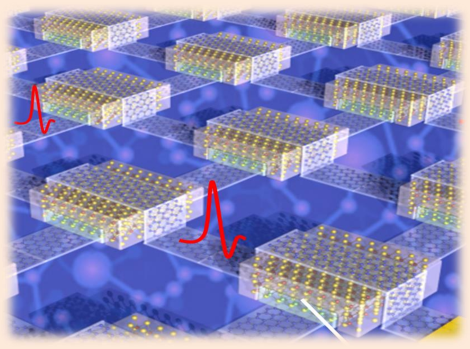
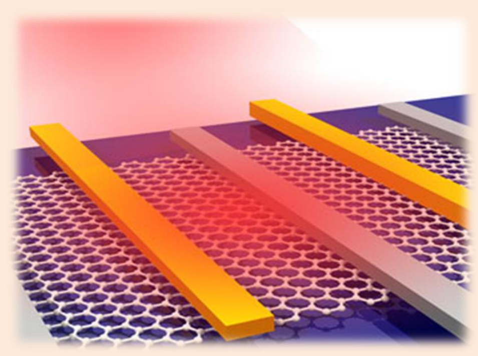
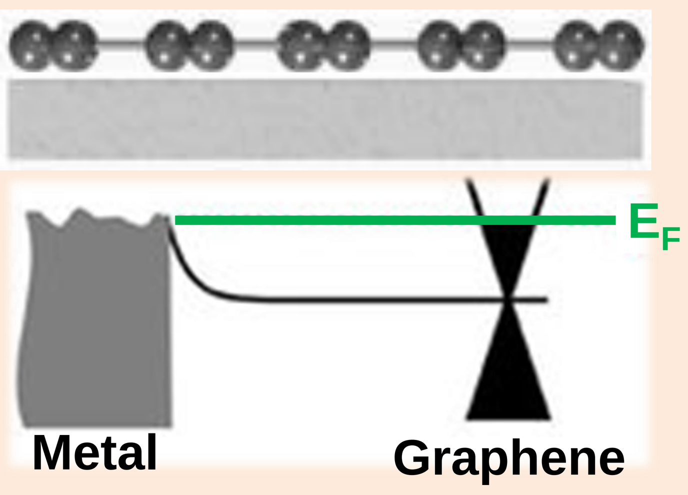
MOTIVATION AND CHALLENGES


Flexible electronics


Transparent electrodes

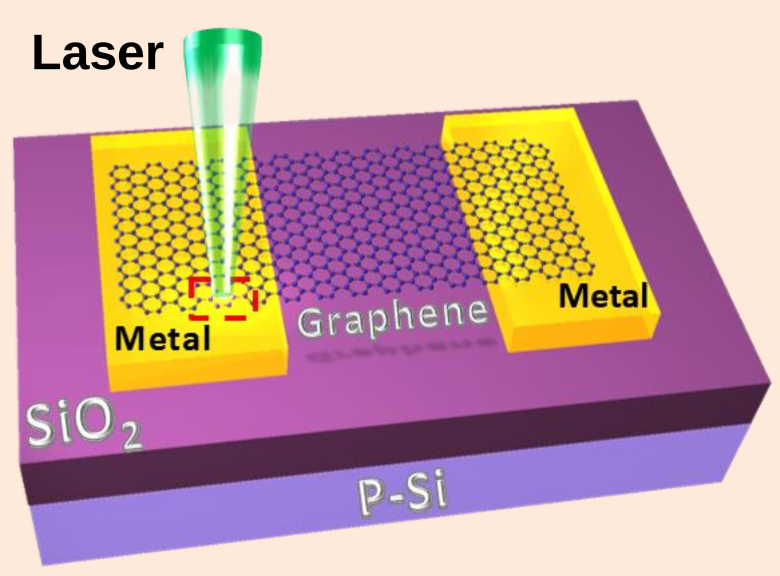

Optoelectronics



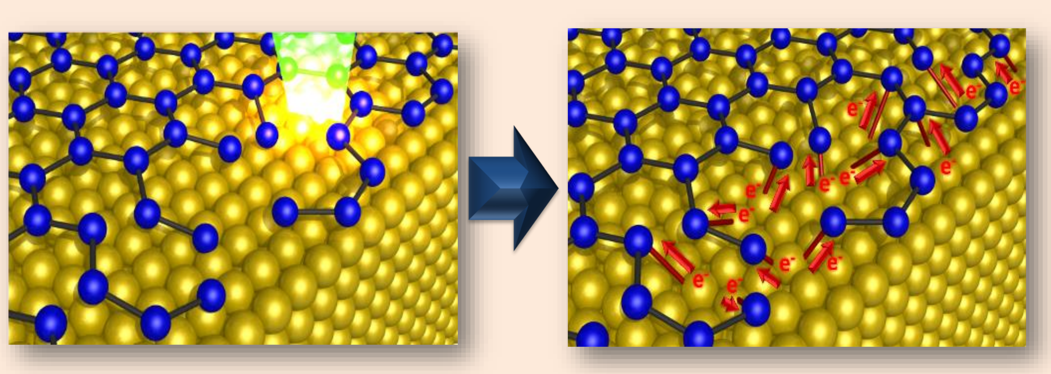
- The large graphene-metal contact resistance is a major limitation for development of graphene electronics.
- graphene behaves as an insulator for out-of-plane carrier transport to metallic contacts.

PROPOSED SOLUTION

Laser nano-welding of graphene to the metal contacts



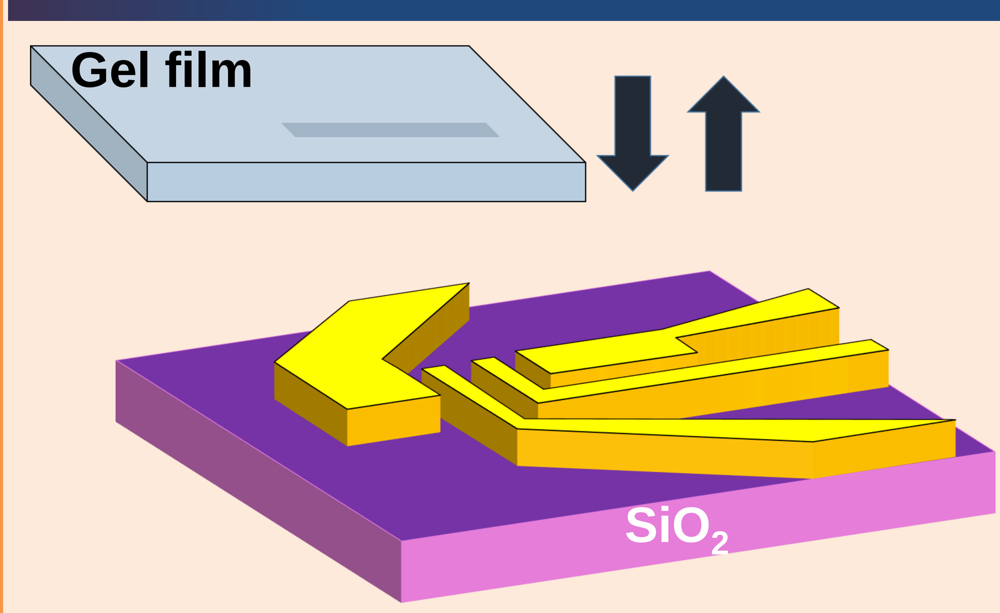
- Laser-induced formation of defects.
- Increase the chemical reactivity of graphene.
- Avoid unwanted damage to channel region.

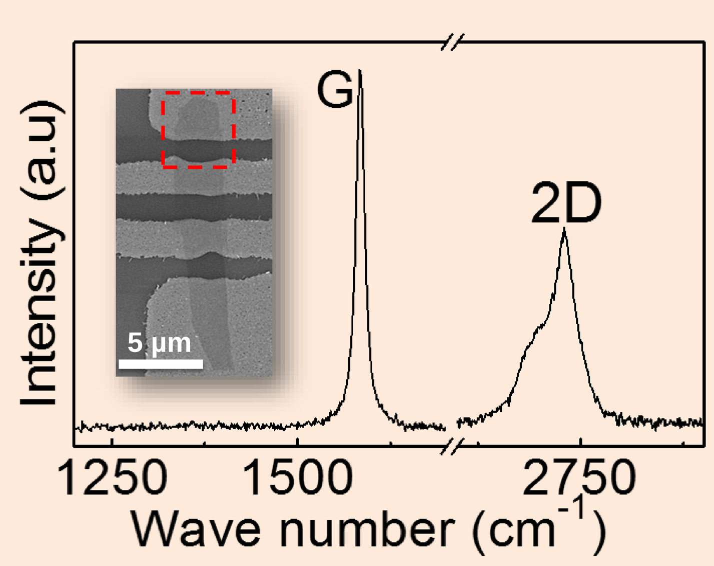


❖ Realization of a strong G-M bonding at laser-induced defects.

METHODS

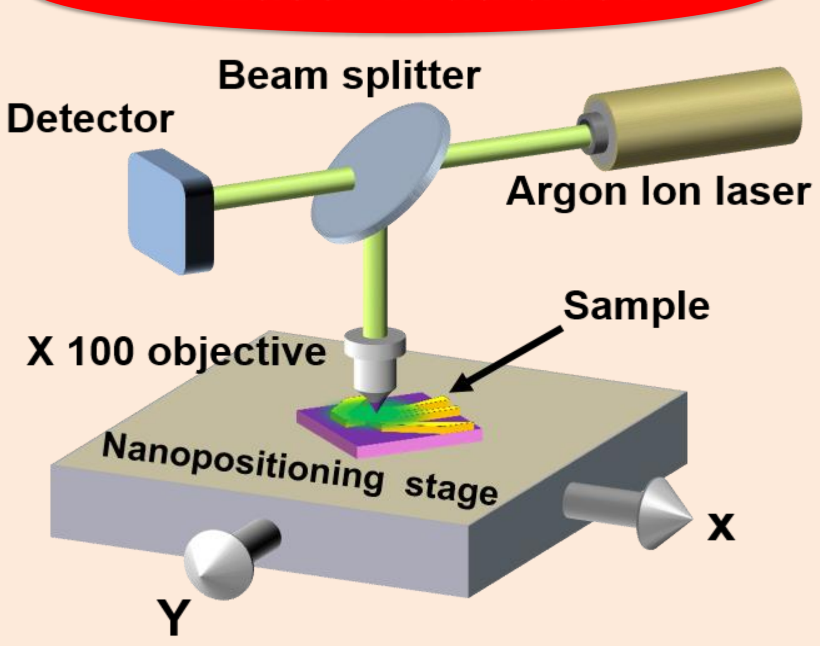
I. Fabrication of the four-point probe structures





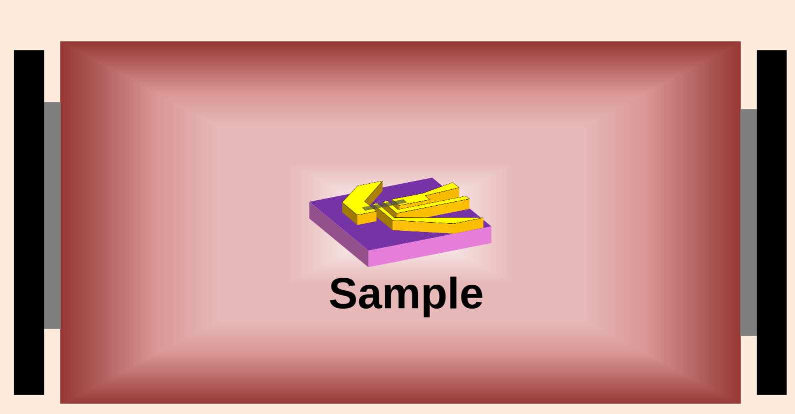
II. Laser nano-welding of graphene

A. Laser irradiation



- Wavelength: 514 nm.
- Laser Fluence: 1.6×10^{3} J/cm².

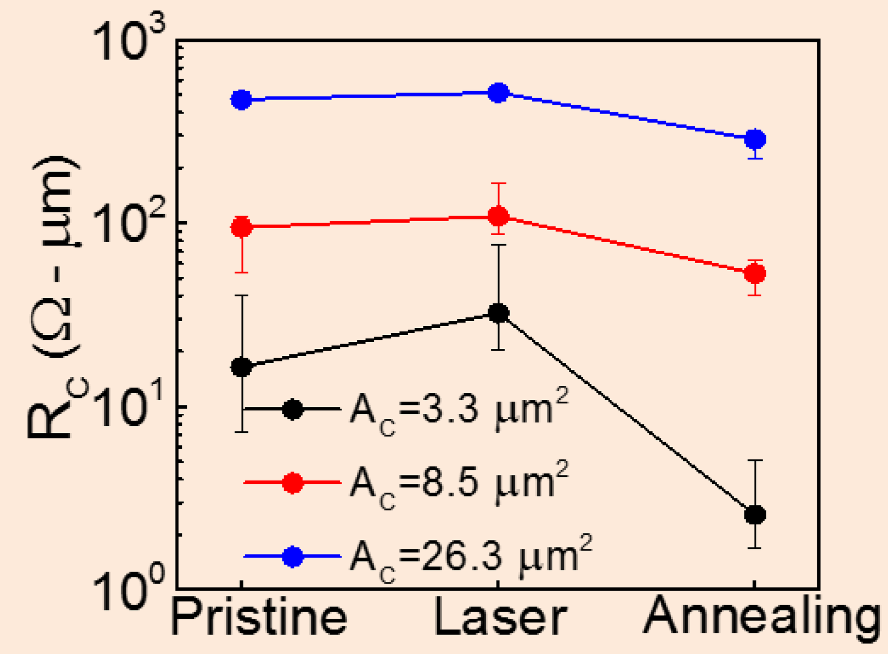
B. Thermal annealing



- Temperature: 400 ºC.
- Time: 1 hr.
- Pressure: 1-5 mTorr (Ar purge).

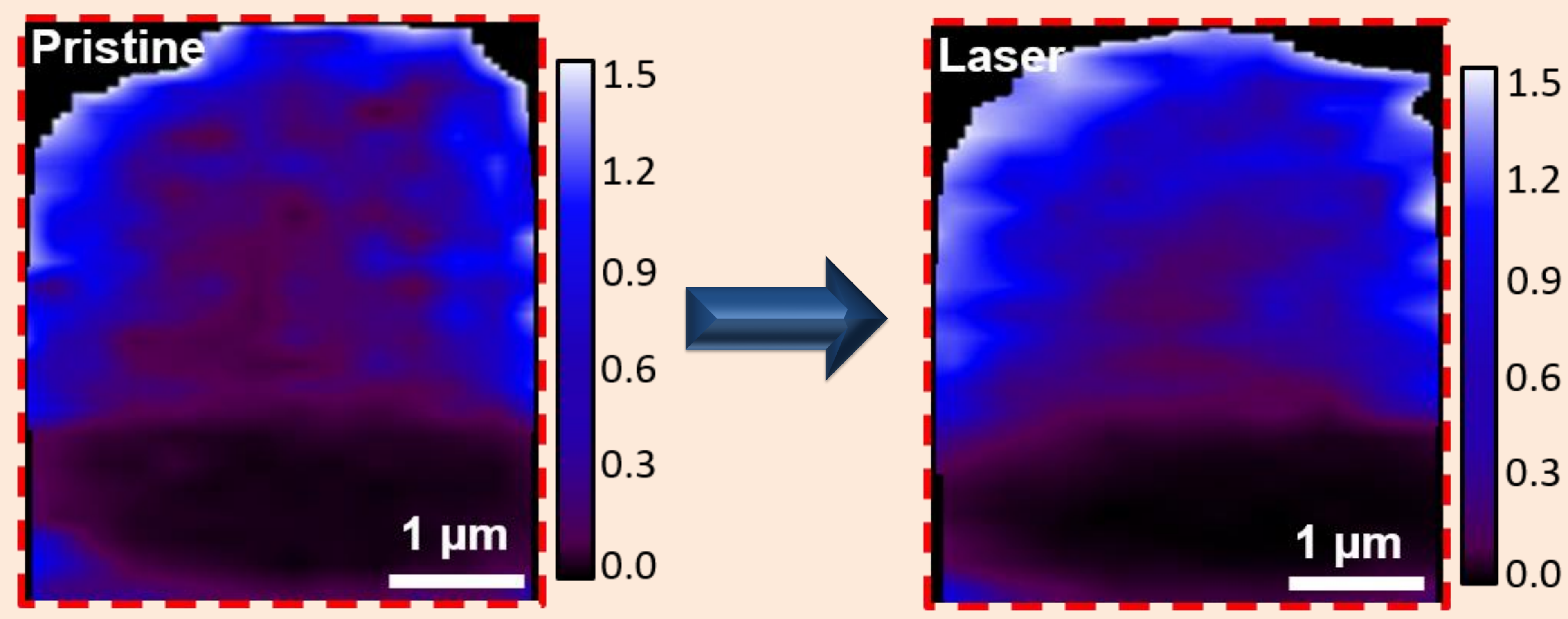
RESULTS AND DISCUSSION

I. Reducing the Contact resistance *via* laser nano-welding



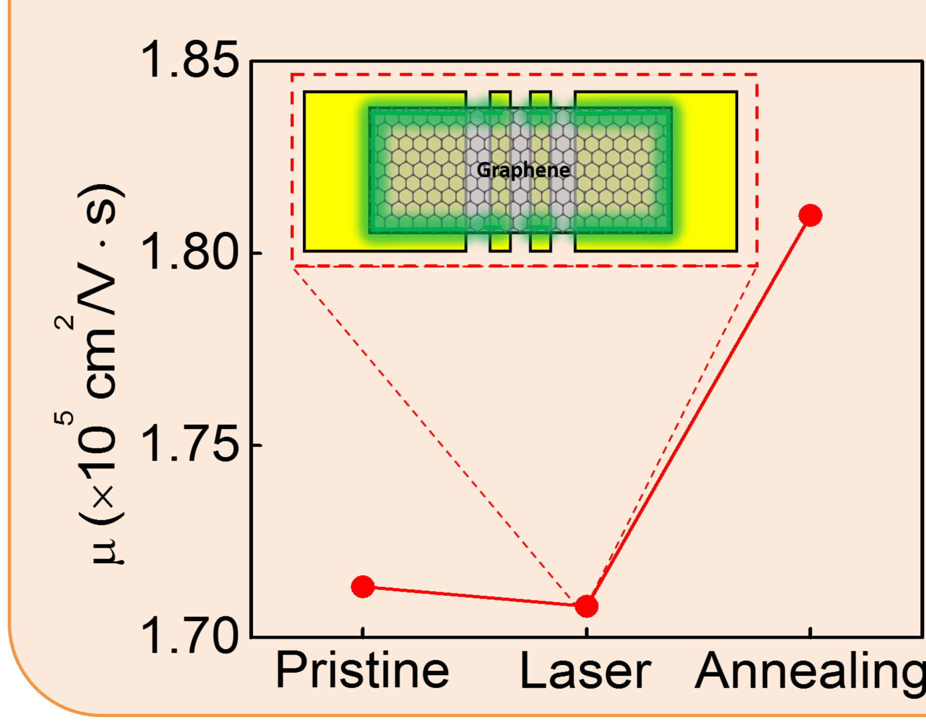
- Slight increase in R_C for all samples after the laser-irradiation.
- Significant reduction of R_C values after the annealing.
- R_C values as low as 2.57 Ω•µm obtained *via* laser nano-welding method.

II. Structural characterization using I_D/I_G Raman mapping



- A rise in the I_D/I_G ratio was observed only at the edges of graphene, where laser irradiation was performed.
- No change was observed at the channel region and the middle of graphene-metal interface.
- Performance degradation was avoided, due to selective mechanism of the laser-irradiation.

III. Carrier mobility



- Slight reduction in the mobility after the laser irradiation.
- Increased mobility after the thermal annealing.
- Improved carrier injection efficiency, due to the bonding formation at the edges of graphene.

CONCLUSIONS

- Laser nano-welding was developed and led to R_C reductions of up to 84%.
- Localized laser irradiation at the edges of graphene led to the formation of chemically active point defects.
- Precise structural modifications and formation of G-M bonding led to improved carrier efficiency in graphene devices.

ACKNOWLEDGEMENTS

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