

# Conclusion

The thesis, I presented, is the result of two research activities, carried out in two huge and excellent Academic Institution, The Microfabrication Laboratory of Georgetown University in Washington DC, USA, and the Centre for Graphene Science at Exeter University in UK, with the intense support of the University of Salerno.

This thesis explores the electrical and optical properties of a new unique two dimensional atomic crystal - graphene.

The results performed in both fields (electrical and optics) give us interesting and novel aspects of the properties of this material, allowing us to publish papers in prominent journals.

Here, I summary the important results obtained.

The study of the visibility of Graphene has been investigated experimentally, the role of interaction between substrate and the graphene sheets represents a crucial aspect for the potential application in the fabrication of graphene-based devices.

I reported a study of effect of the specific contact resistivity of metals as (Ti and Ni) in graphene transistors. In conclusion, we contend that the resistivity is modulated by the back gate, with the same dependence as the channel resistance. Concerning the transfer characteristic of a GFET, we have clarified the nature of the double dip often observed in the p-branch. We have shown that it is related to charge transfer between the graphene and the metal contact and that it is enhanced by the hysteresis provoked by charge storage at the graphene/SiO<sub>2</sub> interface.

I presented, the first observation of field emission current from the inner, flat part of single- and few-layer graphene. Taking advantage of a special setup, I investigated FE currents by applying electric fields up to 2 kV/μm. High and stable FE current (up to 1 μA), is well described by the usual FN model over several orders of magnitude (5) and it is a stable process for few hours.

Regarding the optical properties and the fabrication of optical devices, we have shown that graphene can be used as an excellent substrate for plasmonic (metallic)

nanoparticles. Our experiments have shown that the plasmon resonances associated with metallic nanoparticles are retained when graphene is used as the substrate.

Taken together these results show that the combination of graphene and the plasmonics of metallic nanoparticles offer great promise, for example for flexible and transparent electronics and for advanced bio- and chemical sensors.

The discovery of this new material brings with it some of the most exciting and fruitful periods of scientific and technological research. With a new material, new opportunities to reexamine old problems come as well as pose new ones.

Finally, there are still many open questions to clarify a more detailed studies to carry on.