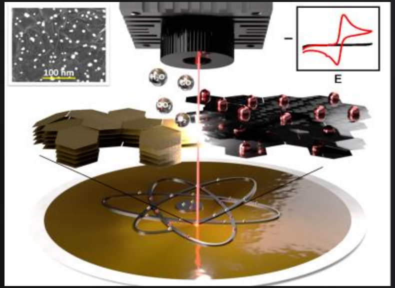
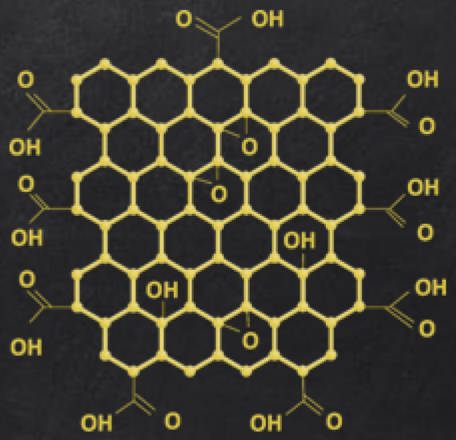
Laser production of reduced graphene oxide electrodes and other graphene-based nanocomposites

Dr. Ruslán Alvarez
Andy Bruno
ICN2

Laser production of reduced graphene oxide electrodes and other graphene-based nanocomposites

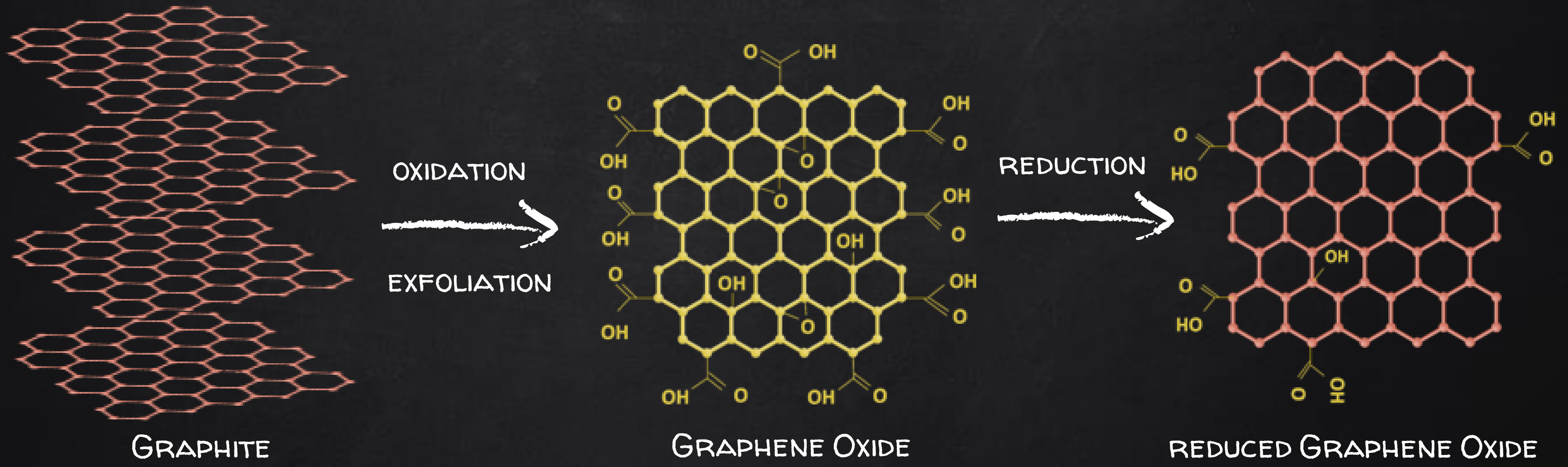


Dr. Ruslán Alvarez
Andy Bruno
ICN2



Graphene Oxide

Graphene oxide is a highly oxidized form of graphene that contains oxygen-containing functional groups, making it more soluble and easier to process than reduced graphene oxide. Can be easily dispersed in water or other solvents, making it ideal for coating onto various substrates.


GRAPHITE
OXIDATION
EXFOLIATION
GRAPHENE OXIDE
REDUCTION
REDUCED GRAPHENE OXIDE

Graphene Oxide

Reduced Graphene Oxide

1. Chemical reduction: reducing agents such as hydrazine, sodium borohydride, or ascorbic acid to reduce the oxygen content in graphene oxide and restore the sp2 hybridization of the carbon atoms.

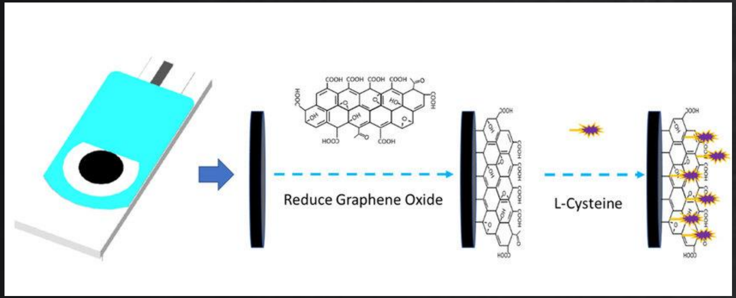
2. Thermal reduction: heating graphene oxide to high temperatures in a reducing atmosphere such as hydrogen, ammonia or argon. The high temperature drives off the oxygen-containing functional groups and restores the sp2 hybridization of the carbon atoms.

3. Electrochemical reduction: This involves the use of an electrochemical cell with graphene oxide as the working electrode and a counter electrode immersed in an electrolyte solution. By applying an electric potential, the oxygen-containing functional groups are removed from graphene oxide and it is reduced.

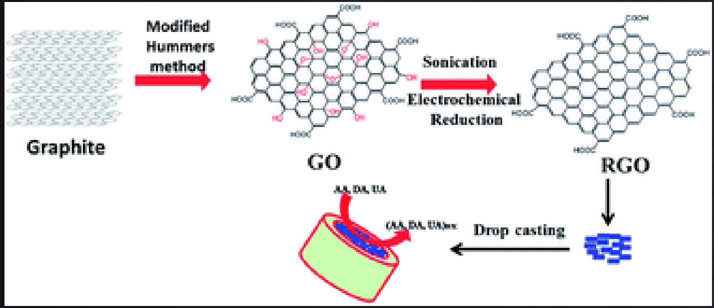
4. Photoreduction: This involves exposing graphene oxide to light, which promotes the reduction of the oxygen-containing functional groups and the restoration of the sp2 hybridization of the carbon atoms.

5. Microwave-assisted reduction: microwave radiation to promote the reduction of graphene oxide. The high-energy radiation induces a rapid and uniform heating of the sample, leading to reduction of graphene oxide.

Why?



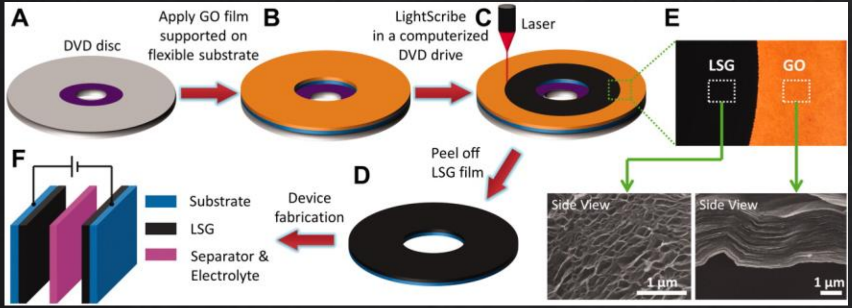
Hou, X., Xiong, B., Wang, Y., Wang, L., & Wang, H. (2020). Sensors, 20(5), 1322.



Aneesh, P. K., Nambiar, S. R., Rao, T. P., & Ajayaghosh, A. (2014).. Analytical Methods, 6(14), 5322-5330.

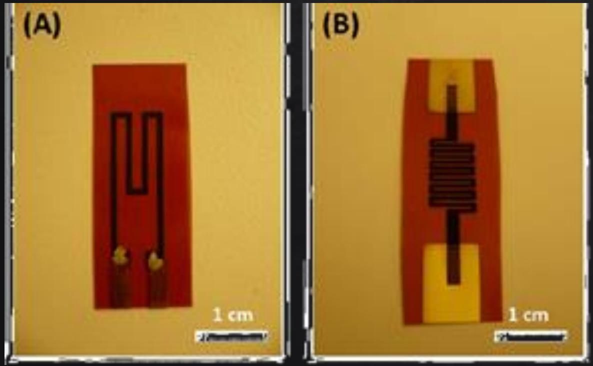
- Laser reduction is a powerful method for reducing graphene oxide to graphene while patterning it at the same time.
- Unlike other reduction methods, laser reduction allows for precise control of the reduction degree and pattern.
- This means that laser reduction can produce graphene-based nanocomposites in the desired shape, without the need for additional steps.
- Additionally, laser reduction is scalable and can be used to produce large quantities of high-quality graphene-based nanocomposites for various applications.

State of the art



El-Kady, M. F., Strong, V., Dubin, S., & Kaner, R. B. (2012). Laser scribing of high-performance and flexible graphene-based electrochemical capacitors. Science, 335(6074), 1326-1330.

Chyan, Y., Ye, R., Li, Y., Singh, S. P., Arnusch, C. J., & Tour, J. M. (2018). Laser-induced graphene by multiple lasing: toward electronics on cloth, paper, and food. *ACS nano*, *12*(3), 2176-2183.

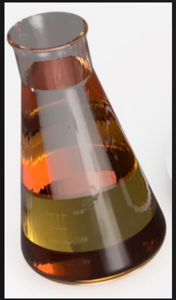


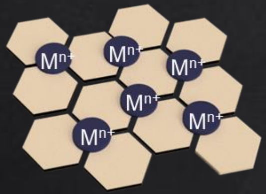
Marengo, M., Marinaro, G., & Kosel, J. (2017, October). Flexible temperature and flow sensor from laser-induced graphene. In 2017 IEEE SENSORS (pp. 1-3). IEEE.

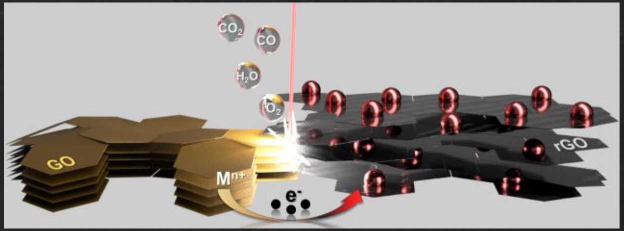

Tirana
Summer
School

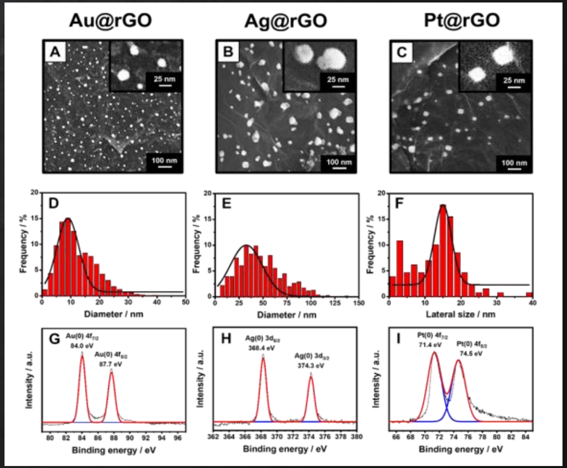
Equipment and Materials

From 300€

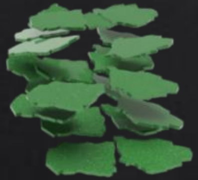


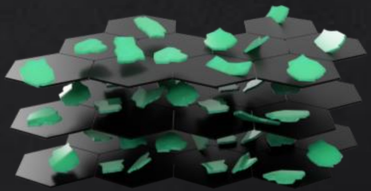


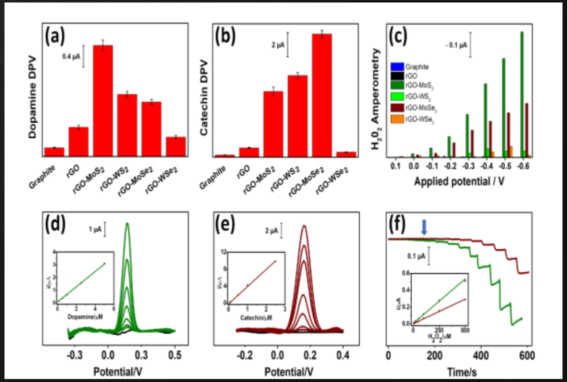




MoS_2 WS_2 $MoSe_2$ WSe_2







Team Presentation

Caterina Giacomelli

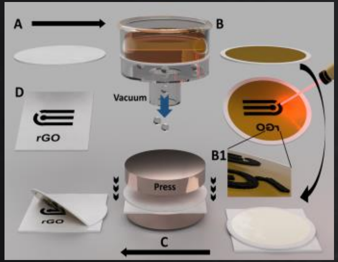
Dr. Flavio Della Pelle

Dr. Annalisa Scroccarello

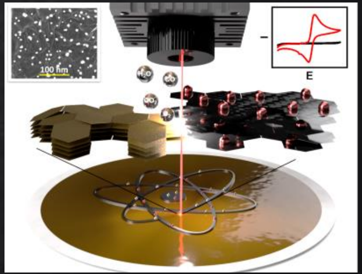
Dr. Andrea Idili

Dr. Claudio Parolo

Prof. Arben Merkoçi



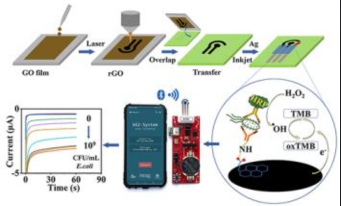
2D materials (2020), 7(2), 024006.



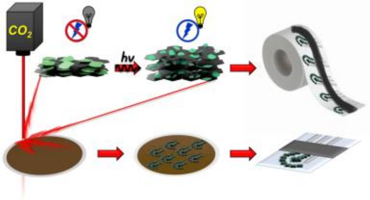
ACS Sens. 2023, 8, 2, 598–609

THANKS!

Any questions?



ACS Appl. Mater. Interfaces 2023, 15, 7, 9024−9033



Nanoscale 2023 https://doi.org/10.1039/D2NR07157F

You can find us at

www.nanobiosensors.org

ICN2 Institut Català de Nanociència i Nanotecnologia — EXCELENCIA SEVERO OCHOA — SUSNANO — GRAPHENE FLAGSHIP — NANO Bioelectronics & Biosensors Group