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"Laser Induced Graphene for Soft Electronics, Sensors and Functional Surfaces"

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Laser Induced Graphene (LIG) is a porous conductive carbon material produced by laser-induced pyrolysis of various polymer precursors. LIG fabrication on polyimide was first described in 2014 and ever since the research on this material has attracted much attention, especially for its technological applications. An infrared or other (UV, vis) laser sources are used to this purpose. The photothermal pyrolysis process allows for fast and maskless scribing of circuits onto insulating precursors in ambient condition, thus enabling new developments in flexible/stretchable/wearable electronics, electrochemical sensors, energy harvesting and storage, soft robotics, among others.[1–4]
Here, we present some results of our group on: 1) fundamental Investigation of LIG, its structure and properties; 2) technological applications in soft electronics, sensors, functional surfaces.
The LIG morphology and properties (especially conductivity) can be tuned by varying the laser fluence and adjusting the rastering parameters. This results in various LIG types: a flat porous LIG, a dense forest of long carbon nanofibres bundles or a "sponge" structure. A corresponding variation in crystal structure, defects, and surface area is observed. The adoption of a UV laser source with a galvo scanner head enables the reduction in size of scribed features down to 5-10 μm width, with an overall improvement of LIG homogeneity. Also, by locally changing the oxygen content of the atmosphere at the scribing beam spot, a dramatic change of surface wettability is obtained. Tunable wettability over the full range of water contact angle is achieved from superhydrophilic (0°) to superhydrophobic (>150°). Patterns with high wettability contrast can be created, opening the way to various applications in self guiding of fluids over surfaces and biomimetic fog harvesting. Applications in soft, wearable sensors and supercapacitors are obtained by embedding of LIG in thin stretchable elastomers (PDMS, medical grade Polyurethane). These include: stretchable connectors, skin contact electrodes for electrophysiology, sensors for temperature and strain/pressure monitoring, wearable electrochemical sensors for monitoring of urea, tyrosine, pH in sweat.[4,5] Also, we coupled LIG/PDMS with stimuli responsive polymer hydrogels deposited by initiated chemical vapour deposition (iCVD). These were investigated as soft actuating structures with thermal- and moisture-triggered response.[6]
Most recent advancements include the investigation of sustainable approaches to green electronics and sustainable soft robotics . Several bioderived polymers and raw natural materials (e.g. agricultural and food industry waste, shells, etc) are studied as suitable precursors for LIG and LIG based sensors.

<u>References</u>

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