Laser assisted methods for Materials Synthesis: From biomolecular sensors to flexible electronic applications

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ABSTRACT

The Laser Materials Synthesis (LMS) subgroup focuses on the laser synthesis, generation and patterning of materials using both state-of-the art fs pulsed and continuous sources. Currently the LMS subgroup is involved in two main project with the acronyms EPIGRAPH and SINTERINK.

Specifically, EPIGRAPH's project full title is GRAPHene biomolecular and electrophysiological sensors integrated in an "all-in-one device" for the prediction and control of EPIleptic seizures towards a general device for most brain disorders. At FORTH, ULMNP lab, the LMS subgroup participates in the development of a graphene based biomolecular sensor for glucose and/or lactate detection via state-of-the-art laser processing techniques for better functionalization. Preliminary data indicate that slow changes in glucose and lactate may constitute a predictive biomarker of incoming seizures in epilepsy. Fs laser processing has been used for high precision, high throughput, one-step precise patterning of graphene oxide and graphene on temperature-sensitive substrates. Laser reduced graphene oxide rGO electrodes on polymeric substrates will be incorporated into a single device that will predict (via biomolecular sensing) and stop (via biomolecule delivery) seizure genesis/propagation in an experimental model of temporal lobe epilepsy.

In the SINTERINK project, we develop and demonstrate the technology in operational environment for a manufacturing process incorporating digital multilayer inkjet conductive and dielectric printing (silver, Ag, copper, Cu, and barium titanate, $BaTiO_3$, single-crystal nanoparticle inks) complemented by direct laser sintering. The printing of metal or dielectric nanoparticle (NP) based inks to produce conductive structures for printed electronic applications requires thermal post-treatment of the printed ink to obtain adequate electrical conductivity, dielectric permittivity and adhesion, without damaging the underlying carrier substrate. Currently, thermal sintering is used for the heating and consequent coalesce of nanoparticles into solid or porous conductive lines. Thermal sintering is time-consuming, energetically inefficient and cannot be applied to many thermoplastic substrates due to their low glass-transition temperatures (Tg). Laser sintering has been demonstrated to be an attractive alternative, allowing a fast and energy efficient process, suitable to be used with temperature sensitive substrates on cost-effective devices such as photovoltaics, energy storage, flexible power electronics, wearable and large-scale electronics.