

New materials and structures for infrared sensing

Ceramic substrates and graphene as a scalable and mechanically flexible platform for optical detection in the infrared

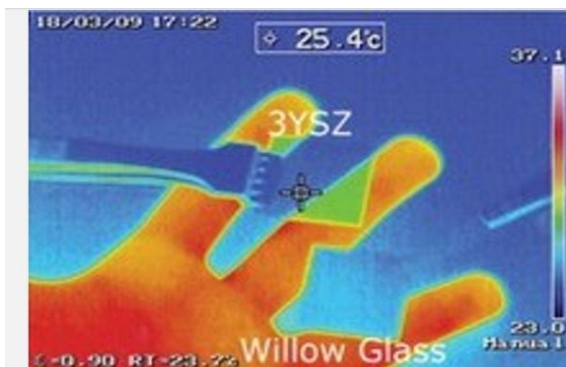
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The Optoelectronics research group led by ICREA Valerio Pruneri studies and develops new advanced materials and devices for the photonics industry as well as search to improve sensing techniques with these materials. In two studies, recently published in NanoLetters and Advanced Optical Materials, a team of ICFO researchers has been able to report on the following achievements that could improve the sensing capabilities of nanostructures based on graphene.

In the first study, ICFO researchers Kavitha K. Gopalan, Bruno Paulillo, Daniel Rodrigo, and Nestor Bareza, led by ICREA Prof. at ICFO Valerio Pruneri, in collaboration with David M.A. Mackenzie, Patrick R. Whelan, and Abhay Shivayogimath from the Technical University of Denmark, have reported, for the first time, using graphene nanostructures and a scalable

nanoimprint technique to fabricate a tunable graphene nanohole array surface capable of sensing plasmonic vibrations in the mid-infrared range ($\sim 1300-1600 \text{ cm}^{-1}$). Such properties make it an interesting nanostructure for industrial applications (such as mid-infrared biosensors or photodetectors) since this technique is capable of exciting multiple plasmon modes, allowing it to do multiband sensing, something not feasible with nanoribbons or other localized resonant structures.

In the second study, ICFO researchers Kavitha K. Gopalan, Daniel Rodrigo, Bruno Paulillo, led by ICREA Prof at ICFO Valerio Pruneri, in collaboration with Kamal K. Soni from Corning Inc, have reported on the use of yttria-stabilized zirconia (YSZ) ceramic as a flexible and stable platform for infrared nano-optics. In their study, the team of researchers combined the YSZ substrate with metallic nanostructures and graphene to demonstrate new plasmonic, polarizing, and transparent heating devices, overcoming the frailness and long-term functionality issues that other substrates, such as calcium fluoride and zinc selenide, present. They also showed that this material is mechanically flexible, ideally suited for making foldable or bendable devices, and for low-cost large-scale roll-to-roll fabrication processes. Such discovery proves that this material is ideal for infrared applications, which could cover thermal imaging to chemical and biological vibrational spectroscopy, among others.



IR camera image of the ultra-thin YSZ ceramic.