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Materials sensitive to laser light with high environmental compatibility

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Photopolymers are light sensitive materials that nowadays are being tested for different holographic and diffractive applications: Holographic data storage, diffractive optical elements, etc. These materials contain monomers, dyes and crosslinkers with a high level of toxicity. Therefore, they have low environmental compatibility and the change from the laboratory to industrial scale implies many risks for workers and general population. This is a very important consideration if these materials would be used for a massive production of common devices. The holography and optical processing team at the University of Alicante in Spain has developed a new type of photopolymer according to the principles of the green chemistry and the sustainable design of materials. These photopolymers have photochemical features similar to the standard material but with an improved design related to environmental aspects. They could be used as recording media for holographic memories, optical elements, sensors or other applications where a light sensitive material would be necessary.

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Simultaneous experimental observation of the quantization and interference of a nano-confined plasmonic near-field

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Miniaturized plasmonic and photonic integrated circuits are generally considered as the core of future generations of optoelectronic devices, due to their potential to bridge the size-compatibility gap between photonics and electronics. However, as the nanoscale is approached in increasingly small plasmonic and photonic systems, the need to experimentally observe and characterize their behaviour in detail faces increasingly stringent requirements in terms of spatial and temporal resolution, field of view, and acquisition time. This work focuses on a specific electron microscopy technique, Photon-Induced Near-Field Electron Microscopy (PINEM), which is capable of imaging optical evanescent fields and surface plasmon polaritons (SPPs) in nano-plasmonic structures with both nanometer and femto second resolution. In analogy to photons, SPPs exhibit both particle and wave behaviour, and each of these aspects has recently been observed in individual, specifically tailored experiments. In this work, a novel 'hybrid'-type PINEM modality is introduced, which allows for synchronous probing along both energy and space degrees of freedom, thereby enabling the simultaneous observation of both particle and wave aspects of SPPs in a single experiment. To do so, ultrafast light and electron pulses are spatio-temporally overlapped on a single silver nano-antenna suspended on a graphene film. The resulting quantized energy exchange between single probing electrons and the photo-induced plasmonic near-field is analyzed using an advanced electron energy filter. In PINEM spectroscopy mode, the exchange of up to 30 photon quanta with the photo-induced SPPs in silver nano-antennae is observed. In PINEM imaging mode, the spatial properties of the photo-induced SPP standing wave on single silver nano-resonators are shown to be controlled by the polarization of the optical pump pulse. Finally, in the novel hybrid acquisition mode - which synchronously characterizes the electron-SPP interaction along both a spatial coordinate and energy - both the characteristic spatial interference and the energy quantization of the photo-induced SPPs are obtained in the same experiment, providing a unique visualization of their dual nature.

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