Au nanoparticles/InZnO thin film prepared by laser annealing for wide range photodetector applications

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ABSTRACT:

The development of alternative methods of integrating electronic devices has become a major issue in the context of the Internet of Things (IoT). Among these basic components, photodetectors are important devices for applications in health, sports or more generally sensors.
We propose a new method for preparing gold nanoparticles (Au NPs)/indium-zinc-oxide (IZO) nanocomposite thin films based on photothermal mechanisms with near-Infrared (NIR) laser-annealing, which allows integrating the nanomaterial on fragile substrates such as thin glass, plastic sheets, or 3D printed pieces. The Au NPs were first prepared by NIR laser dewetting of a thin Au layer. Then, the Au NPs were used to locally cure the semiconductor material and provide suitable electronic properties owing to their efficient thermoplasmonic effects under our NIR laser annealing conditions. Finally, the electronic properties of the Au NPs/IZO thin films were characterized in the dark and under light excitation. Good photoresponsivity at 410 nm (UV, > 10^0 A/W) was demonstrated, but interestingly, the presence of Au NPs significantly improved the detection ability to a longer wavelength range, such as to 515 nm (green, ~ 5 × 10^{-3} A/W), even extending to 630 nm (red, ~ 5 × 10^{-4} A/W), and 780 nm (NIR, ~ 10^{-4} A/W). In addition, with the critical evaluation of dynamic light detection and lifetime trace (> 22 days), the laser-annealed Au NPs/IZO photodetector (PD) demonstrated useful operating reliability and stability.

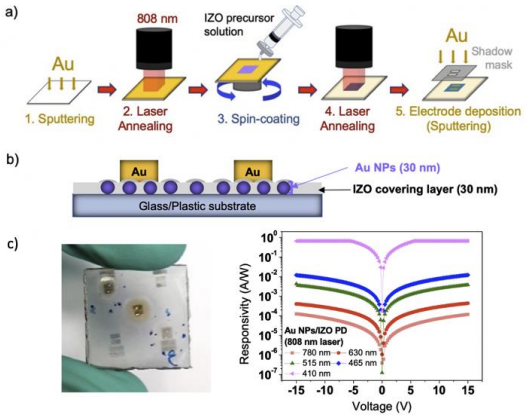

Figure 1 : a) Schematic view of the Au/IZO nanocomposite thin film preparation by laser annealing, b) Schematic view of the photodetector structure, c) Example of device on polymer substrate and photoresponse curves from UV to NIR.

Reference

[1] C. C. Yeh, H. W. Zan, O. Soppera, Advanced Materials 2018, 30, 24.
[2] C.-F. Lin, A. Khitous, H.-W. Zan, O. Soppera, Advanced Optical Materials 2021,2100045.