

Plasmon resonance wavelength modification in xerogels co-doped with Fe₃O₄/Au core-shell nanoparticles and Ag ions

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The Faraday effect is a nonreciprocal phenomenon in which the polarization direction of light rotates under a magnetic field. This effect is enhanced by coating magnetic nanoparticles with a plasmonic metal, where the resonance wavelength depends on the metal type, shape, size, and surrounding refractive index.[1] In this study, we aimed to control the plasmon resonance wavelength by depositing Ag nanoparticles on Fe₃O₄/Au core-shell nanoparticles embedded in a xerogel, induced by focused femtosecond laser irradiation in a xerogel co-doped with Ag ions. Fe₃O₄ nanoparticles were synthesized by co-precipitation and coated with Au using HAuCl₄ and NH₂OH/HCl. Xerogels were prepared by a sol-gel process with aminopropyltriethoxysilane, incorporating the core-shell particles and 0.05 mol% Ag ions. Laser irradiation (4.9 nJ/pulse, 80 μm/s) caused a refractive index change. Figure 1 shows the optical absorption spectra before and after irradiation, where the resonance peak shifted from 540 nm (Au) to 430 nm (Ag). Figure 2 shows Faraday effect measurements at 488 nm, where the slope of the rotation angle versus magnetic field in the irradiated region decreased by 12.1% compared to the non-irradiated region. This enhancement is attributed to Ag nanoparticles deposited on the core-shell particles, which is induced by laser irradiation. Additionally, we attempted to fabricate a waveguide-type device based on this system. Evaluation results will be presented at the conference.

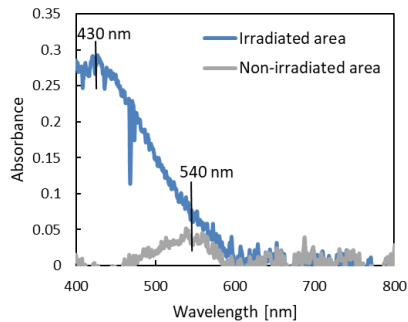


Figure 1: Optical absorption spectra before and after laser irradiation.

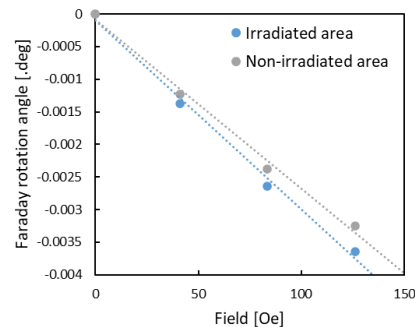


Figure 2: Faraday effect measurement in the irradiated area.

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References:

[1] Prashant K. Jain, Yanhong Xiao, Ronald Walsworth and Adam E. Cohen et al, Nano Lett, 9(4), pp.1644-1650(2009)