Imaging metallic nanoparticles in deep tissue by using saturated scattering of near infrared light

Kentaro Nishida[1,2], Gitanjal Deka[3], Nicholas I. Smith[4], Shi-Wei Chu[3], Katsumasa Fujita[1,2]

[1] AIST-Osaka University Advanced Photonics and Biosensing Open Innovation Laboratory, AIST, [2] Department of Applied Physics, Osaka University, [3] Department of Physics, National Taiwan University, Roosevelt Rd., Taipei, Taiwan, [4]Immunology Frontier Research Center, Osaka University, Yamadaoka, Suita, Osaka, Japan

E-mail : fujita@ap.eng.osaka-u.ac.jp

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The saturation effect in optical phenomena introduced high-order nonlinearities between incident and signal light and has been utilized for super resolution imaging [1, 2]. We previously reported saturated excitation (SAX) microscopy using the saturation effect in fluorescence excitation and plasmonic scattering from gold nanosphere probes [1, 3]. In particular, the plasmonic nanoparticle probes showed the large scattering cross-sections and photostability, allowing us to obtain high contrast images from a deep part of tissue. We observed gold nanosphere probes distributed under a muscle tissue, and confirmed the improvements of image contrast and spatial resolution by SAX microscopy using a CW excitation at 561 nm [3].

In this research, we used the saturation effect of plasmonic scattering of near-infrared (NIR) light from gold nanoshells to increase the penetration depth in tissue imaging. Gold nanoshells exhibit the plasmon resonance with NIR excitation light and produce strong scattering light. We measured the relation between excitation and scattering intensities from isolated gold nanoshells by using laser scanning microscopy, and experimentally confirmed that plasmonic scattering from a single gold nanoshell showed the saturation effect by irradiating a CW laser light at 780 nm. We also performed SAX imaging of gold nanoshell probes that distributed within phantom that mimicking muscle tissue. At the observation depth of 400 μm, the SAX image showed the improvements of both of image contrast and spatial resolution.

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