Femtosecond laser-induced acoustic wave emission from gold nano-colloidal suspensions; shape dependence

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In recent studies, photoacoustic (PA) wave emission from gold nano-particles induced by nanosecond laser irradiation was reported and the mechanism was attributed to non-radiative relaxation dynamics of surface plasmon resonance. However, thermal instability and shape deformation of gold nano-particles which result in decay of PA signal intensity were reported. In this presentation, an enhanced PA signal intensity from gold nano-colloidal suspensions with different particle shapes under the condition of tightly-focused femtosecond-pulsed laser (800 nm, 1 kHz, 35 fs) irradiation was investigated. PA signal intensity from gold nano-colloidal suspensions in a glass tube was measured by ultrasound transducers at frequencies of 5, 10, and 25 MHz. Sample suspensions were with gold nano-spheres (diameter = 20 nm) with an absorption peak at 520 nm, and gold nano-rods (35 x 12 nm) with absorption peaks at 520 nm and 800 nm which correspond to transverse and longitudinal surface plasmon resonance, respectively. Fig. 1 (a) shows a representative PA signal in time domain; the first peak represents the fundamental ultrasound signal and the second peak corresponds to the internal reflection of ultrasound waves from the inner surface of the glass tube with diameter of 5 mm. The time interval between the two peaks is 4.22 μs which can be ascribed to the sound velocity in bulk gold (v =3,240 m/s), not in water (v =1,482 m/s). Fig. 1 (b) shows the linear-dependence of the relative PA amplitude at 5 MHz to various shapes of gold nano-particles at different laser power. The longitudinal absorption band of gold nano-rods at the wavelength of 800 nm, which coincides with the wavelength of the femtosecond laser, leads to higher PA signal generation. On the other hand, gold nano-spheres without effective absorption at the laser wavelength generate lower PA signal intensity. No significant shape deformation of gold nano-rods and nano-spheres was observed before and after the experiments under our experimental conditions. Hence, thermal stability and increase in acoustic wave emission from femtosecond laser-irradiated gold nano-particles was demonstrated.

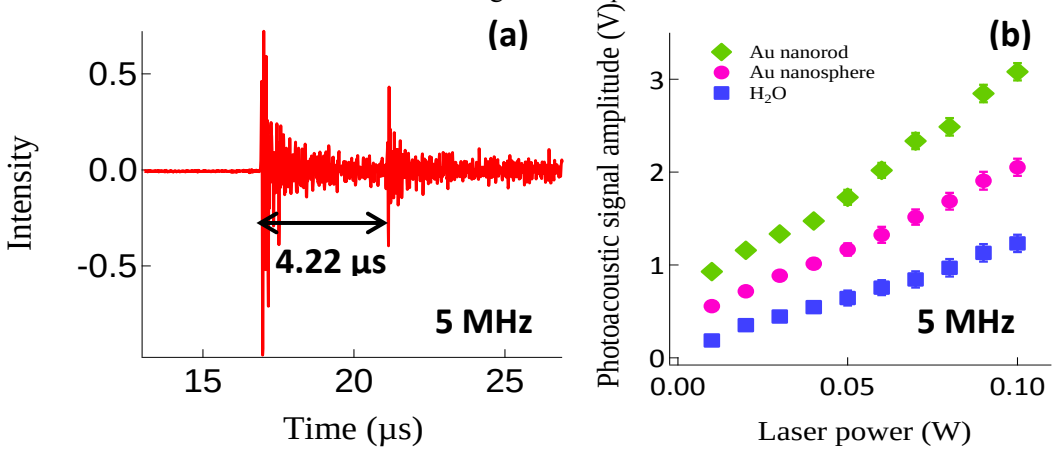

Fig. 1 Representative PA signal in time domain (a) and PA amplitude dependence with laser power (b)