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Microfluidic control by temporally modulated thermoplasmonics

時間的に制御されたサーモプラズモニクスによるマイクロ流体駆動

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Thermoplasmonic gold nanoparticles (NPs) have garnered considerable attention in recent years as fast responce nanoheaters which drive microfluid thermally. However spatially arranged two dimentional gold NPs array allows us to choose heating area spatially, fabrication of such an array is fairly costly. In addition, it absorbs only a few 10% of the incident light even at the wavelength of the local plasma resonance.

Recently, we demonstrated the self-assembling of gold NPs/ dielectric layer/Ag mirror sandwiches, namely, the local plasmon resonators, by using a dynamic oblique deposition (DOD) technique [1]. Due to strong interference, their optical absorption can be controlled between about 0% and 97% by changing the dielectric thickness, and their photothermal conversion efficiency can be spatially tuned by the interference. In our previous work, we demonstrated their strong photoacoustic emission, and showed that highly localized optical absorption in the gold NPs array (∼ 10 nm) realizes strong temporal moduration of local fluid temperature [2]. Thus, the local plasmon resonators can be expected to establish spatio-temporally modulated temperature gradient within a microfluidic channel and to manipulate microfluid flexibly. This is the fundamental study of microfluidic control by temporally modurated heat generation using local plasmon resonators.

The local plasmon resonators were prepared by DOD. On a fabricated sample, a PDMS channel with 25 μm height were prepared. The channel was filled with water in which 0.75 μm diameter polystyrene spheres (PSs) were dispersed in order to visualize the flow. Then, the sample was irradiated with 785 nm wavelength laser (Fig. 1(a)). During the laser irradiation, the motion of PSs was recorded using a CCD camera.

Figure 1(b) shows a typical CCD image and PSs are observed as small dark dots. When the laser is switched on, the high optical absorption sample drastically drives PSs, whereas the low optical absorption sample doesn't drive them. These results suggest that the PSs motion can be modurated by optical absorption of the samples. A detailed discussion of fluid manipuration under temporally modulated thermoprasmonics will be presented.

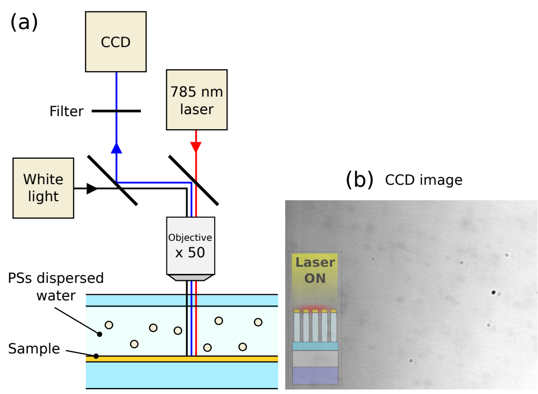

図 1: (a) Experimental setup for thermoplasmonic microfluidic control. (b) Typical image taken by CCD camera.

[1] K. Namura, et al., *Opt. Lett.* **36,** 3533 (2011).

[2] K. Namura, et al., *J. Appl. Phys.* **114,** 074308 (2013).