Fractional optical vortex creates deflected 'spin-jet'

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Optical vortex carries a ring-shaped intensity profile with a central dark core, and an orbital angular momentum characterized by a topological charge ℓ [1]. In recent years, we have discovered that the optical vortex creates a spinning jet of the irradiated high viscosity donor with a straight flight, that is a 'spin-jet' [2]. Such 'spin-jet' provides us an advanced printing technology with high spatial resolution beyond the conventional laser induced forward transfer.

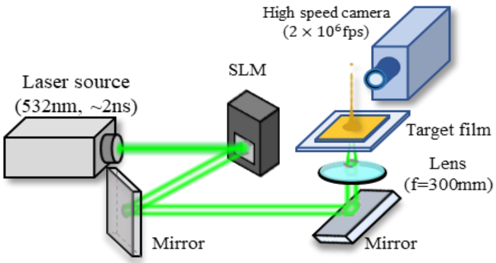

Fig.1 : Experimental setup.

Fractional optical vortex, formed of the coherent superposition of two Laguerre-Gaussian (LG) modes with different topological charges, exhibits an asymmetric ring-shape intensity profile and non-integer topological charge [3].

In this presentation, we report on the deflection of the high-viscosity donor 'spin-jet' by employing the fractional optical vortex.

Figure 1 shows an experimental setup. A donor film used was formed of Au micron-scale particles suspension (product of Tanaka precious metals co.) diluted with the organic solvent, and its thickness was measured to be 20 μm. A Q-switched Nd:YAG laser with a wavelength of 532 nm and a pulse duration of 2 ns was employed as a pump source, and its output was converted into a fractional optical vortex with ℓ = 0~1 by employing a spatial light modulator. The generated fractional optical vortex was loosely focused to be a spot with a diameter of 80 μm on the donor film. The pulse energy was then measured to be 52 μJ. Deformation of the irradiated donor film was then observed by an ultra-high-speed camera from the side at a frame rate of 2×10^6 fps.

The optical vortex produced the 'spin-jet' with the straight flight as shown in Fig. 2(a). The fractional optical vortex also forced the donor film to generate the 'spin-jet'. However, the generated 'spin-jet' was deflected towards the left, manifesting the curved trajectory (Fig. 2(b)). The deflection angle was approximately proportional to Δℓ (=1-ℓ) as shown in Fig. 2(c). Such deflected 'spin-jet' will enable the scanning of 'spin-jet' without a mechanical system.

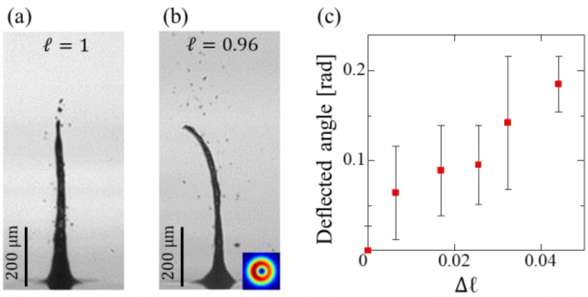

Fig. 2 Au particle suspension 'spin-jet generated by (a) optical vortex (ℓ =1), (b) fractional vortex (ℓ =0.96). (c) Experimental plots of deflected angle of the 'spin jet' as a function of Δℓ.

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