Optical vortex induced nano-micro Aluminum structures

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Optical vortex carries a unique ring-shaped spatial intensity, and an orbital angular momentum due to its phase singularity, and it has been applied to various fields, such as optical manipulation, quantum communication, and laser materials processing [1-3].

In this presentation, we report on a nano - micro needle structuring of aluminum (Al) by illumination of picosecond optical vortex pulses. A single optical vortex pulse with a wavelength of 1064 nm, a pulse width of ~20 ps, and a pulse energy of <25 μJ was focused to be an annular spot with a diameter of ~20 μm on a Al substrate, and it twisted the irradiated Al to shape a helical needle with a nanoscale (i.e. helical nanoneedle) owing to the orbital angular momentum (OAM) transfer effects. This helical nanoneedle was transformed into a non-helical microneedle by deposition of several overlaid optical vortex pulses, and its height reached up to ~7 μm.

Such dual-scale Al surface structuring provides a novel physical insight for interaction between OAM and materials, and it also offers an entirely new nano/microfabrication technique towards ultraviolet plasmonic devices.

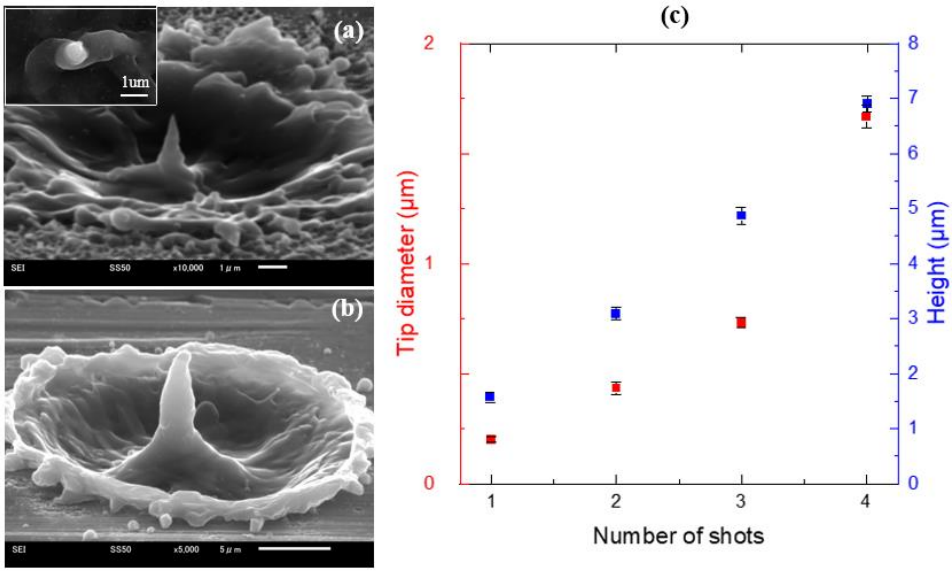

Fig.1 (a) Helical Al nanoneedle (twisted top view is shown in the inset) and (b) non-helical Al microneedle fabricated by a picosecond optical vortex pulse. (c) Tip diameter and height of fabricated needles as a function of the number of overlaid optical vortex pulses.

References

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