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## Fabrication of Artificial Sea Urchin Structure for Light Harvesting Device Applications

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Bioinspired sea urchin-like structures were fabricated on silicon by inductively coupled plasma (ICP) etching using lens-like shape hexagonally patterned photoresist (PR) patterns and subsequent metal-assisted chemical etching (MaCE) [1]. The lens-like shape PR patterns with a diameter of 2  $\mu\text{m}$  were formed by conventional lithography method followed by thermal reflow process of PR patterns on a hotplate at 170°C for 40 s. ICP etching process was carried out in an SF<sub>6</sub> plasma ambient using an optimum etching conditions such as radio-frequency power of 50 W, ICP power of 25 W, SF<sub>6</sub> flow rate of 30 sccm, process pressure of 10 mTorr, and etching time of 150 s in order to produce micron structure with tapered etch profile. 15 nm thick Ag film was evaporated on the samples using e-beam evaporator with a deposition rate of 0.05 nm/s. To form Ag nanoparticles (NPs), the samples were thermally treated (thermally dewetted) in a rapid thermal annealing system at 500°C for 1 min in a nitrogen environment. The Ag thickness and thermal dewetting conditions were carefully chosen to obtain isolated Ag NPs. To fabricate needle-like nanostructures on both the micron structure (i.e., sea urchin-like structures) and flat surface of silicon, MaCE process, which is based on the strong catalytic activity of metal, was performed in a chemical etchant (HNO<sub>3</sub>: HF: H<sub>2</sub>O = 4: 1: 20) using Ag NPs at room temperature for 1 min. Finally, the residual Ag NPs were removed by immersion in a HNO<sub>3</sub> solution. The fabricated structures after each process steps are shown in figure 1. It is well-known that the hierarchical micro- and nanostructures have efficient light harvesting properties [2-3]. Therefore, this fabrication technique for production of sea urchin-like structures is applicable to improve the performance of light harvesting devices.

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## References

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**Keywords:** Sea urchin structure, micro- and nanostructures, ICP etching, MaCE, light harvesting

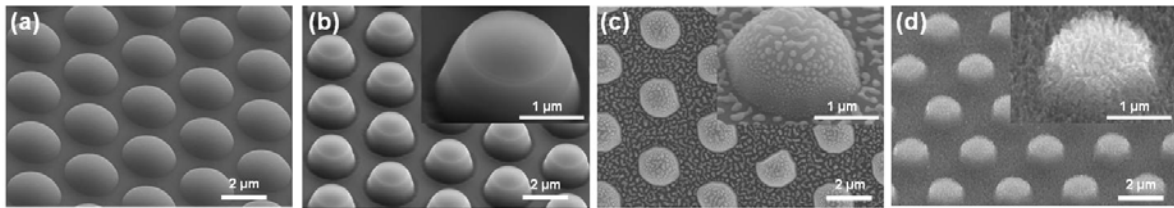


Fig 1. Scanning electron microscope images of fabricated structures after each process steps (a) thermal reflow of PR patterns, (b) ICP etching, (c) thermal dewetting, and (d) MaCE (Inset image shows the fabricated sea urchin-like structure).