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Fabrication of Gold Nanoparticle Pattern Using Combination of Self-Assembly and Two-Step Transfer

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We successfully demonstrated pattern formation of 60 nm gold nanoparticles using a highly productive combined technique of particle self-assembly and subsequent assembled particle pattern transfers. Dot and line patterns of nanoparticles were fabricated on a template substrate (SiO_2/Si) utilizing template-assisted self-assembly (TASA). The obtained dot and line patterns of nanoparticles were transferred to a flexible poly-dimethylsiloxane (PDMS) substrate (the first transfer) and were subsequently transferred onto a gold thin film fabricated on a silicon substrate (the second transfer). We defined a yield of self-assembly as a ratio of the properly assembled area to the total dot-patterned area, and investigated the dependence of the yield on the experimental conditions such as the cross-sectional profiles of the template trench pattern, the concentration of the aqueous particle dispersion, and the cleaning process. It was confirmed that the yield is mainly governed by the width of the template trench. Under optimized conditions, a self-assembly yield of 79% was obtained. The flexible PDMS substrate was used for the first transfer step of the assembled particle pattern and an average yield of 58% was achieved. The second transfer yield onto the gold thin film was 93% using surface-activation bonding between the gold surfaces of the nanoparticles and the thin film. The developed process achieved high patterning accuracy and the misalignment of the dot pattern with the interval of 300 nm was 3.2% on average.

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