Nano-patterns Embedded Micro-pillar structures for Security Identification

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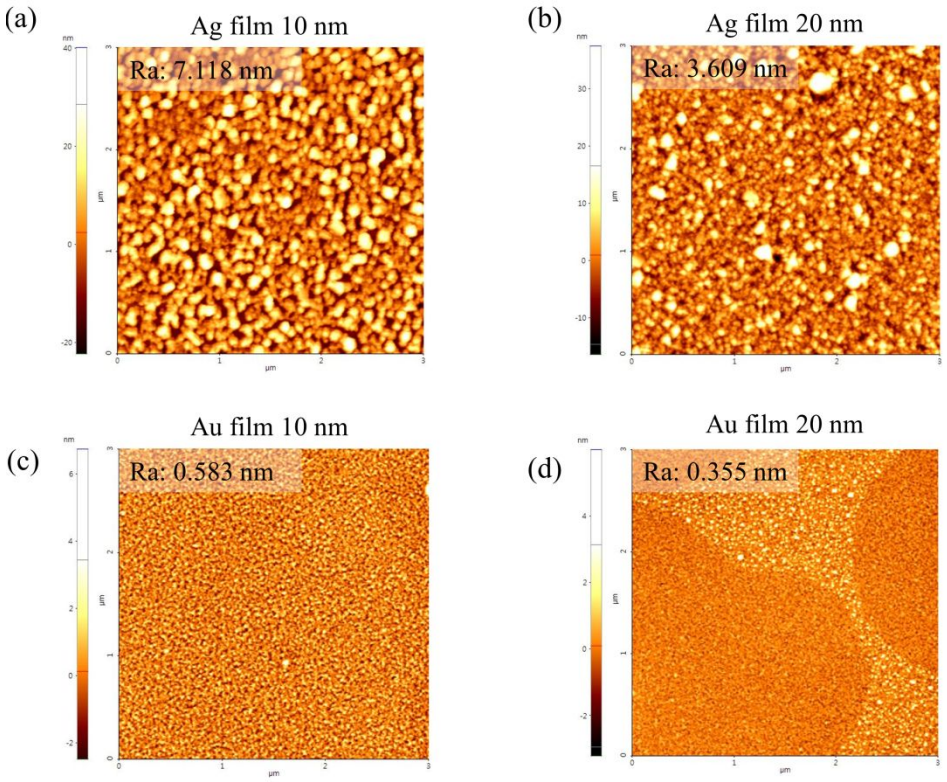


Figure S1. Roughness of Ag and Au film with different thickness. (a) Ag film, 10 nm thick, Ra: 7.118 nm; (b) Ag film, 20 nm thick, Ra: 3.609 nm; (c) Au film, 10 nm thick, Ra: 0.583 nm; and (d) Au film, 20 nm thick, Ra: 0.355 nm.

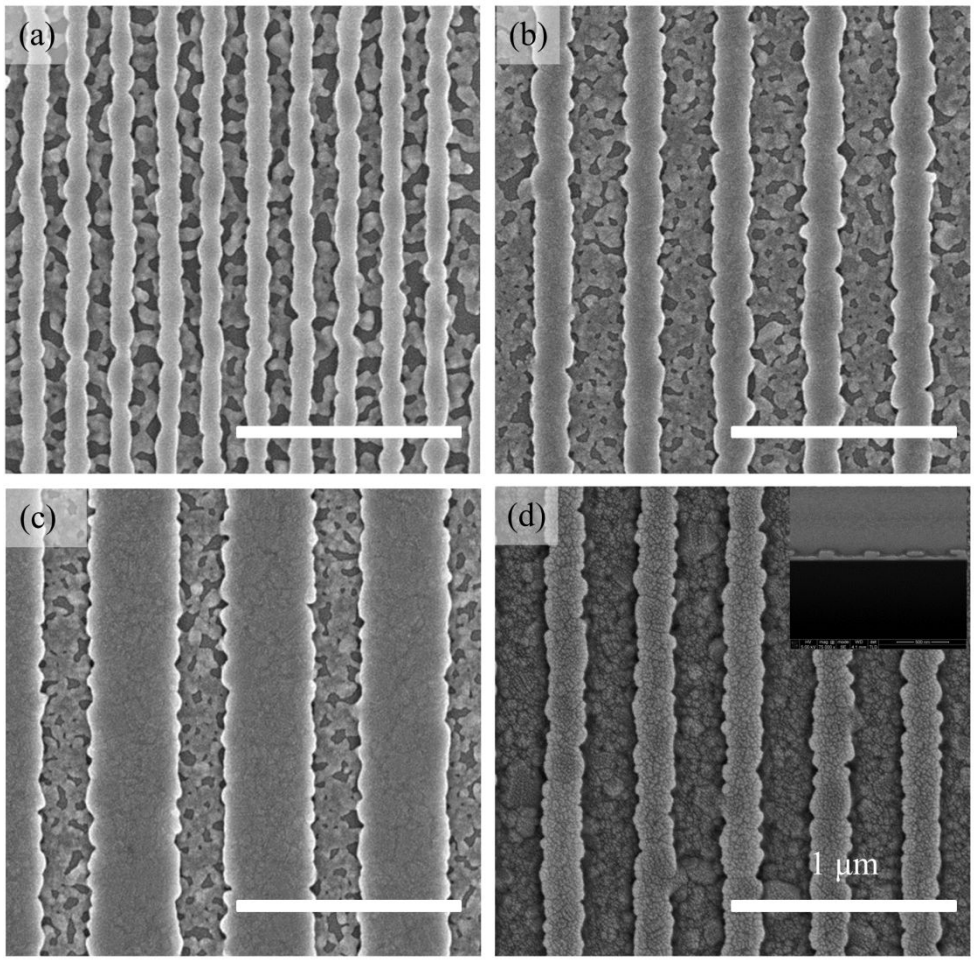


Figure S2. SEM images of Ag nanowires of different size fabricated on Ag nanofilms of different thickness. (a) Ag nanowires, 100 nm (width) x 200 nm (pitch) x 30 nm (thickness), transferred onto Ag film, 10 nm thick. (b) Ag nanowires, 200 nm x 400 nm x 30 nm, transferred onto Ag film, 10 nm thick. (c) Ag nanowires, 400 nm x 600 nm x 30 nm, transferred onto Ag film, 10 nm thick. (d) Ag nanowires, 200 nm x 400 nm x 30 nm, transferred onto Ag film, 30 nm thick (FIB-cross-sectional image is shown in the inset). Nanowelding conditions of all samples: 100 °C.

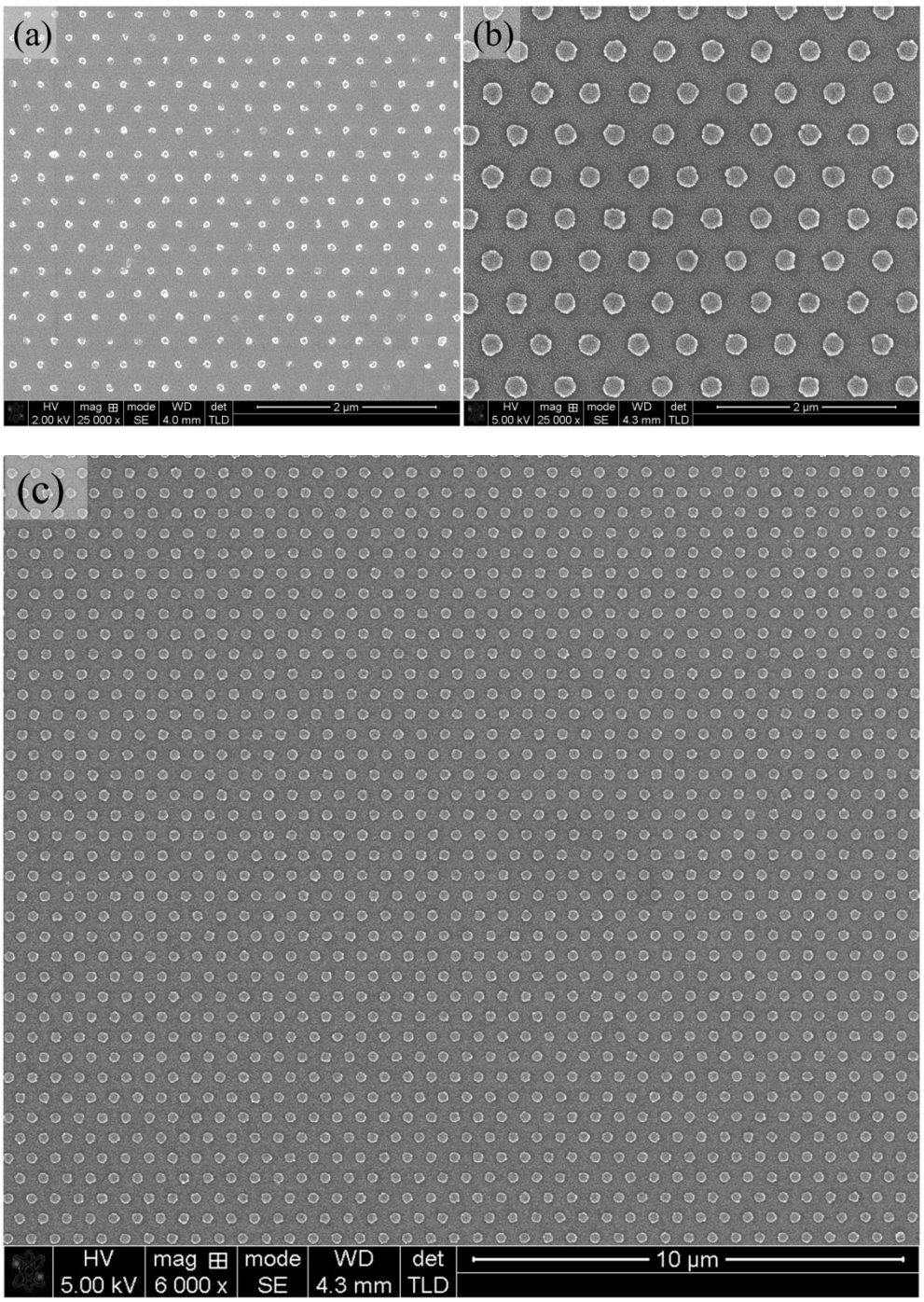


Figure S3. SEM images of dot patterns. (a) 100 nm (diameter) x 150 nm (pitch) x 30 nm (thickness), (b) 256 nm (diameter) x 400 nm (pitch) x 30 nm (thickness), and (c) large scale images of (b). We confirm perfect nanofabrication with no defects.

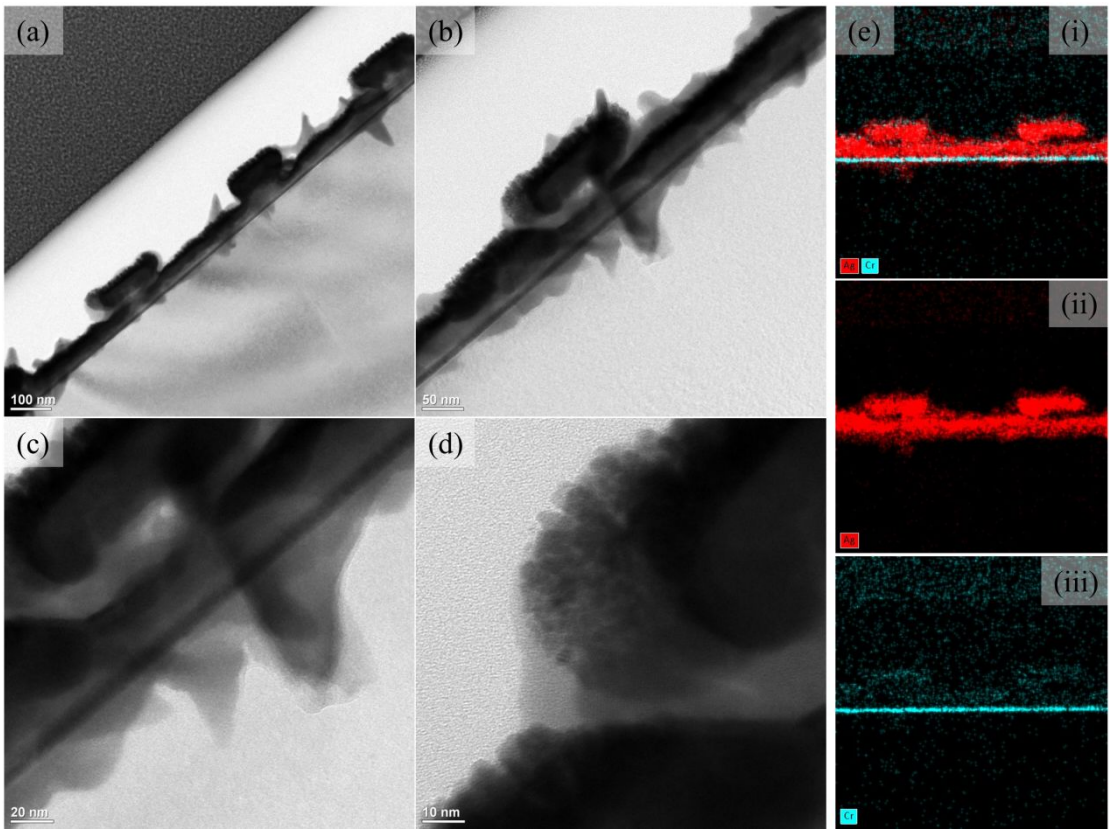
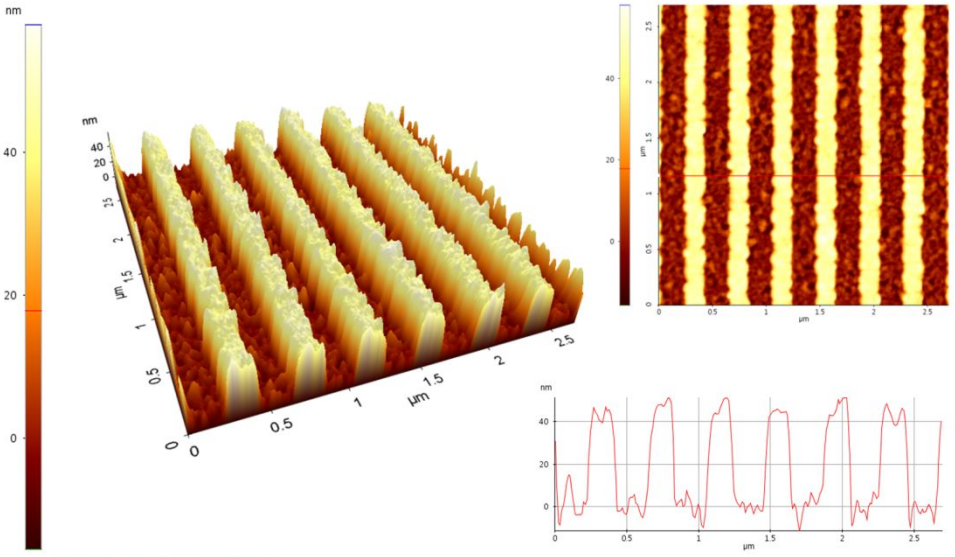
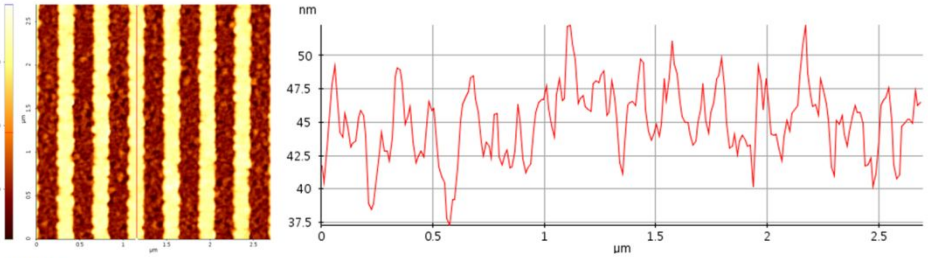


Figure S4. TEM and EDS-mapping images of Ag nanowires, 30 nm thick, fabricated on Ag film of 30 nm thick. (a-d) TEM images and (e) EDS-mapping images.

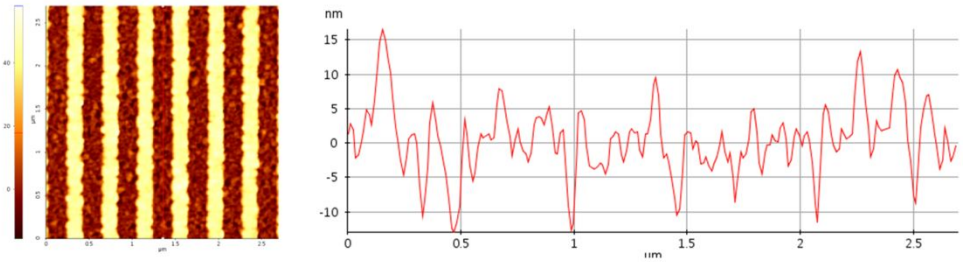
(a)





Statistics

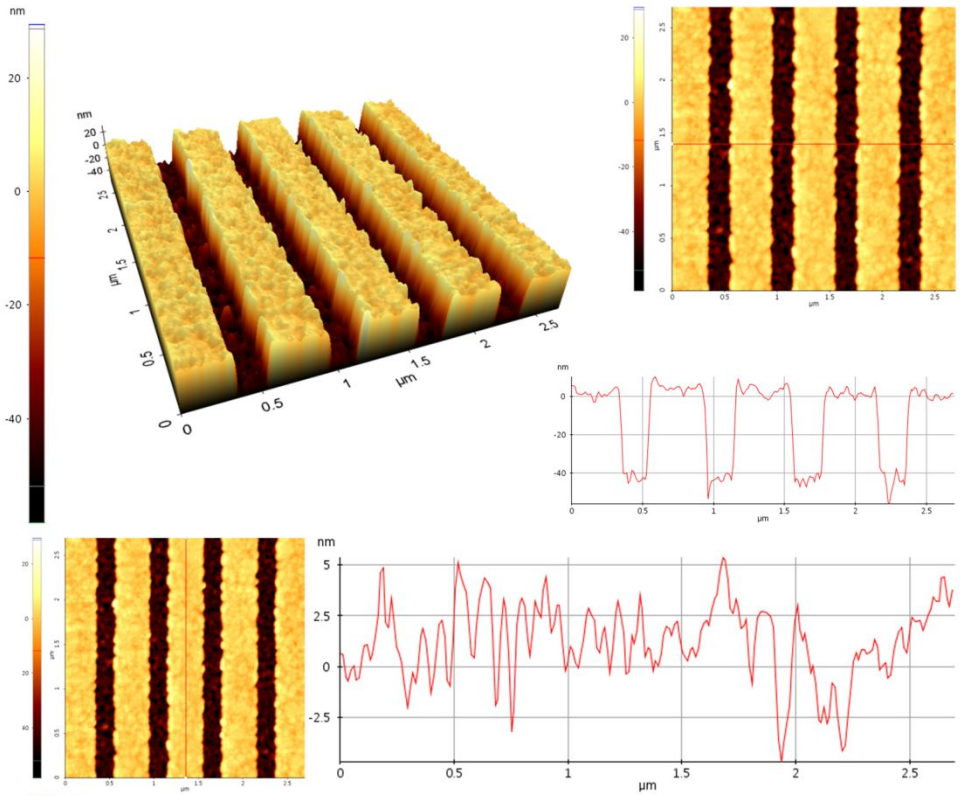
Line	Min(nm)	Max(nm)	Mid(nm)	Mean(nm)	Rpv(nm)	Rq(nm)	Ra(nm)	Rz(nm)	Rsk	Rku
Red	37.285	52.256	44.770	44.995	14.972	2.700	2.139	11.711	0.063	3.110



Statistics

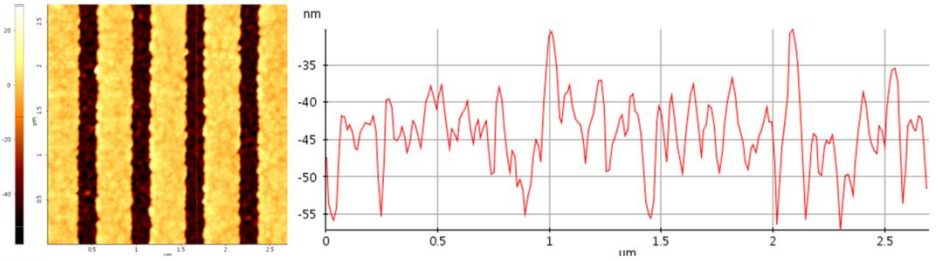
Line	Min(nm)	Max(nm)	Mid(nm)	Mean(nm)	Rpv(nm)	Rq(nm)	Ra(nm)	Rz(nm)	Rsk	Rku
Red	-12.975	16.521	1.773	0.273	29.496	4.985	3.645	23.220	-0.145	4.106

(b)



Statistics

Line	Min(nm)	Max(nm)	Mid(nm)	Mean(nm)	Rpv(nm)	Rq(nm)	Ra(nm)	Rz(nm)	Rsk	Rku
Red	-4.681	5.356	0.338	1.200	10.037	1.905	1.499	8.327	0.500	3.300



Statistics

Line	Min(nm)	Max(nm)	Mid(nm)	Mean(nm)	Rpv(nm)	Rq(nm)	Ra(nm)	Rz(nm)	Rsk	Rku
Red	-57.136	-30.227	-43.681	-44.212	26.909	5.015	3.797	22.108	0.091	3.450

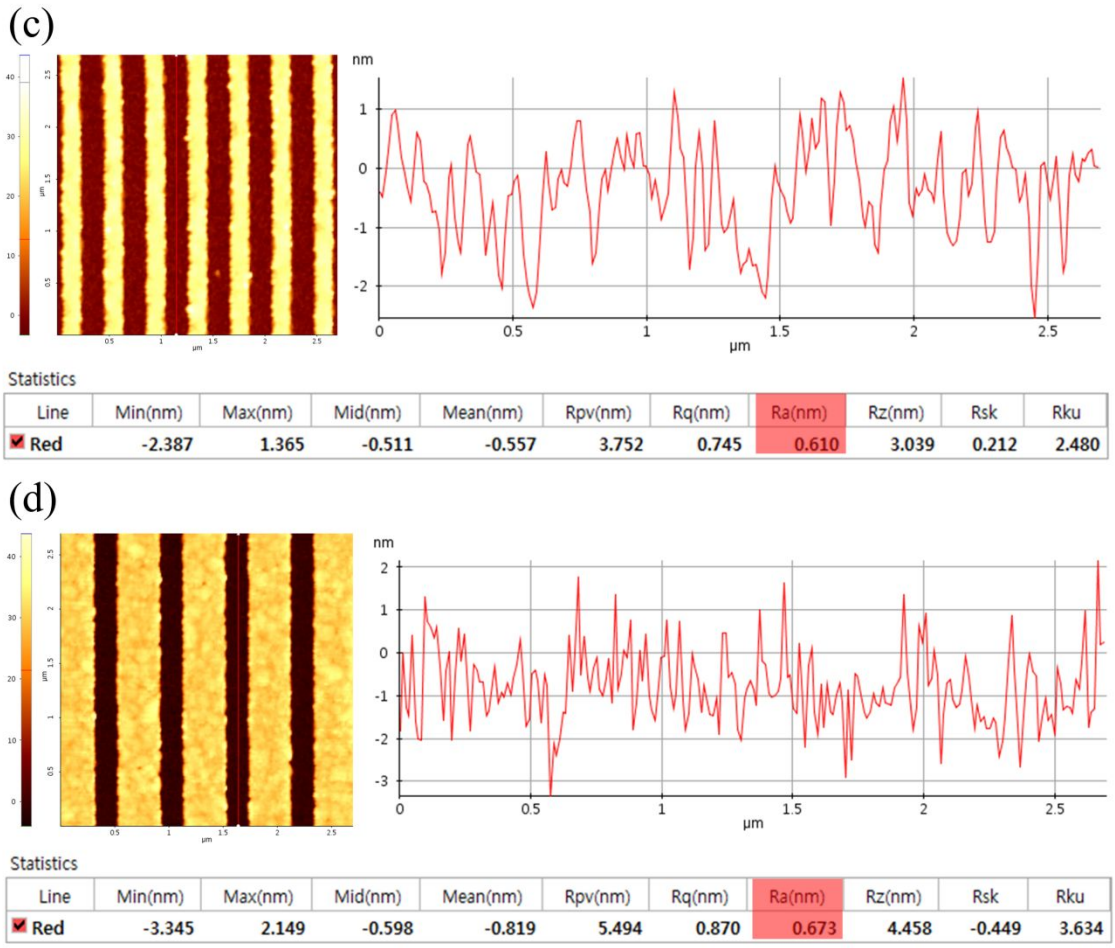


Figure S5. (a) AFM images and roughness of Ag nanowires with dimensions of 200 nm x 200 nm x 30 nm fabricated on Ag film measuring 10 nm thick (Ra of Ag nanowires: 2.139 nm, Ra of Ag film: 3.645 nm). (b) AFM images and roughness of Ag nanowires with dimensions of 400 nm x 600 nm x 30 nm fabricated on Ag film measuring 10 nm thick (Ra of Ag nanowires: 1.499 nm, Ra of Ag film: 3.797 nm). (c) and (d) AFM images and roughness of Ag nanowires with dimensions of 200 nm x 400 nm x 30 nm and 400 nm x 600 nm x 30 nm fabricated on Ag film measuring 10 nm thick ((c) Ra of Au film: 0.610 nm, (d) Ra of Au film: 0.673 nm).

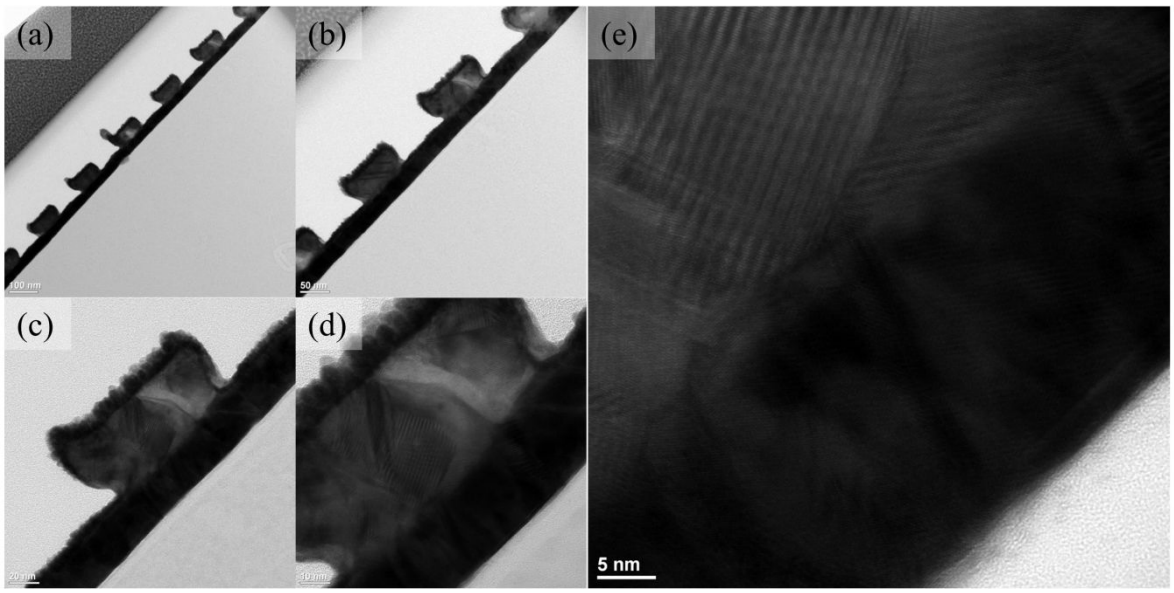


Figure S6. TEM and EDS mapping images of Ag nanowires measuring 100 nm (width) × 200 nm (pitch) × 30 nm (thickness) fabricated on Au dot micropattern surfaces measuring 100 μm (diameter) × 150 μm (pitch) × 30 nm (thickness). (a–c) Low-magnification TEM images (scale bars: 200 nm, 50 nm, and 20 nm, respectively). (d–e) High-resolution TEM images (scale bars: 10 nm and 5 nm, respectively).

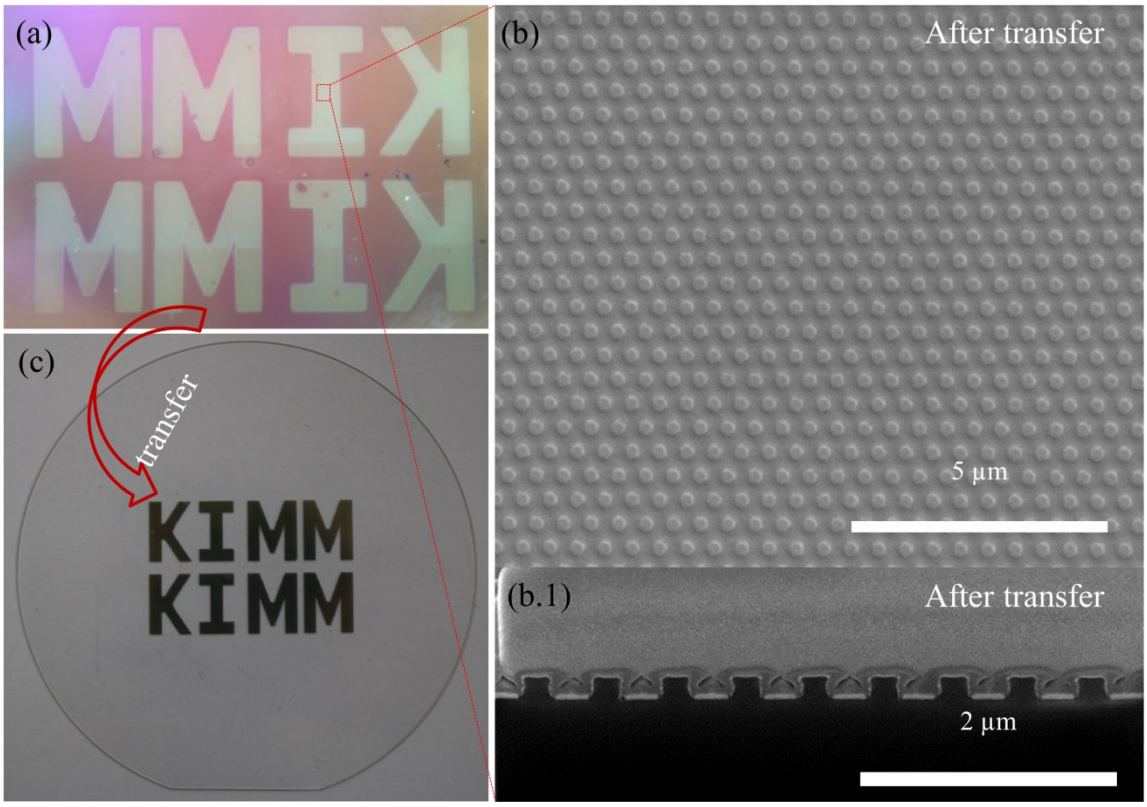


Figure S7. Images of PET film with remaining polymer patterns after transfer. (a) Photograph of PET film after transfer. (b) and (b.1) SEM and FIB-cross-sectional images of dot nanopatterns after transfer (it is evident that the Ag dot nanopatterns were transferred onto the micropattern surfaces). (c) Photograph of art letters with dot micropatterns and nanopatterns.

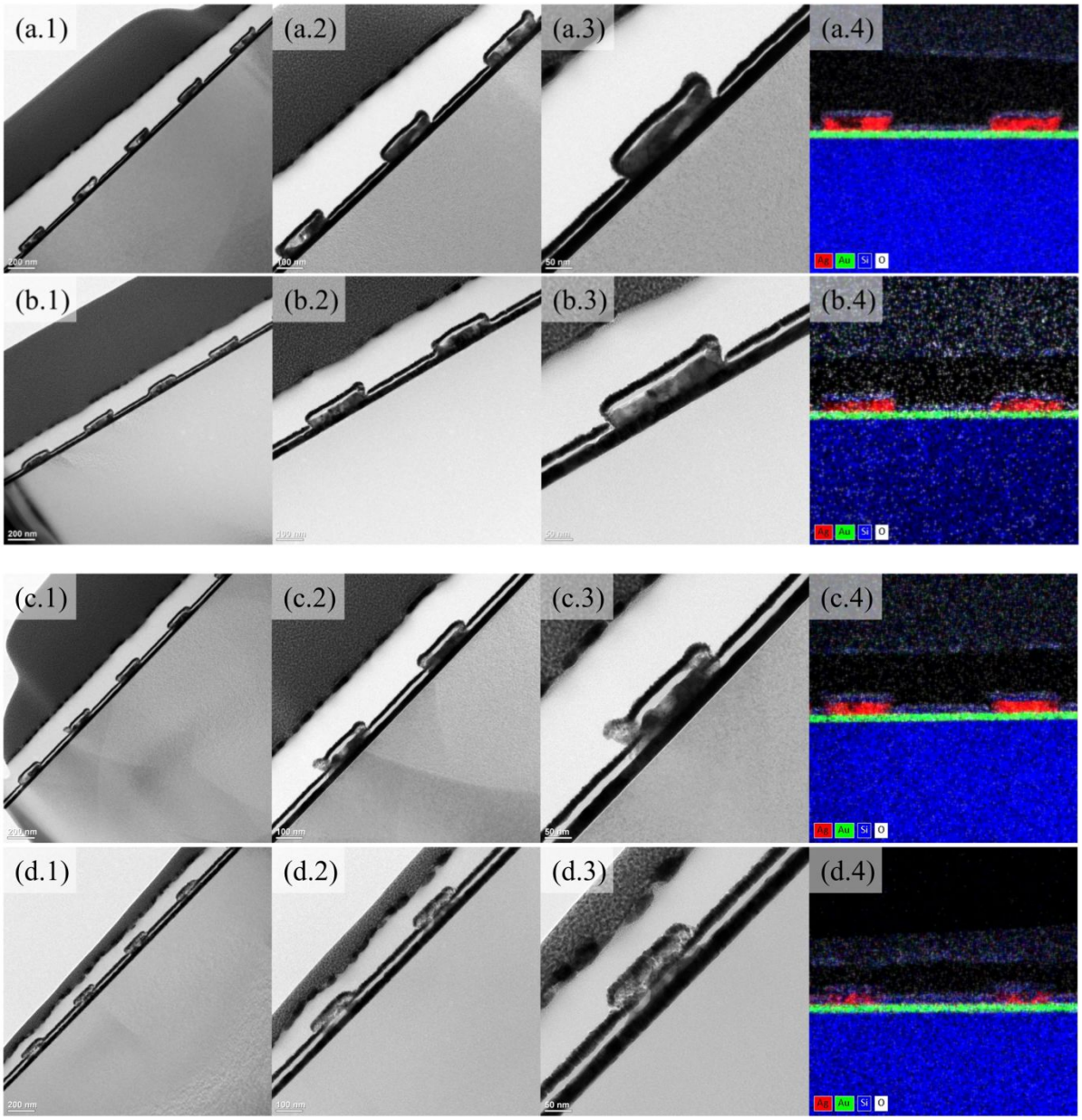


Figure S8. TEM and EDS mapping cross-sectional images of the fabricated samples. (a.1–a.4) SiO_2 layer with thickness of 5 nm, (b.1–b.4) SiO_2 layer with thickness of 10 nm, (c.1–c.4) SiO_2 layer with thickness of 15 nm, and (d.1–d.4) SiO_2 layer with thickness of 20 nm.