Nanoscale

Supporting Information

Strain-induced subwavelength-structure for haze-free and highly transparent flexible plastic substrate

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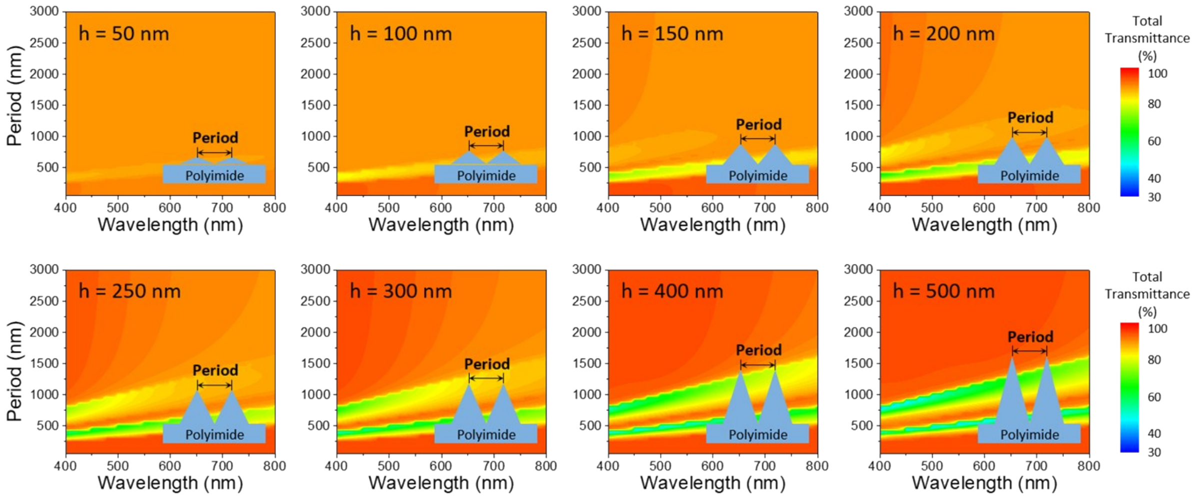

Fig. S1 (a) Calculated total transmittance (T_{total}) of the nanostructured plastic film as functions of period and height of nanostructure. Gap was set to be 0 nm.

The total transmittance of nanostructure plastic films ($n_{plastic}$ = 1.6) was calculated as a function of period and height over the wavelength range of 400 nm to 800 nm (Fig. S1). The schematic structures of the film were illustrated in the inset of the contours. If the period is smaller than 250 nm, the films showed the highest total transmittance. This is mainly because of graded refractive index provided by the nanostructures.

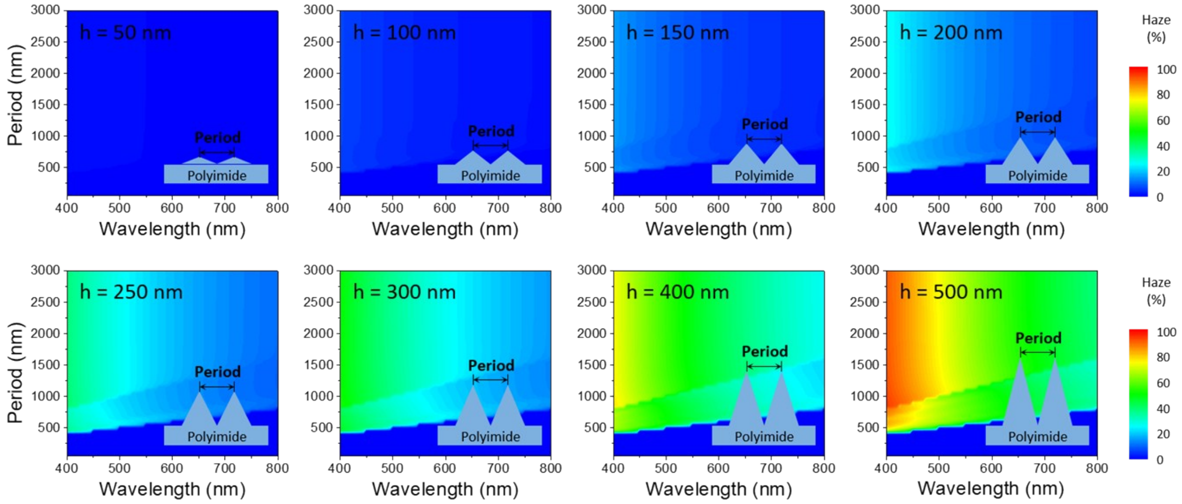

Fig. S2 (a) Calculated haze (H) of the nanostructured plastic film as functions of period and height of nanostructure. Gap was set to be 0 nm.

The haze of nanostructure plastic films ($n_{plastic}$ = 1.6) was calculated as a function of period and height over the wavelength range of 400 nm to 800 nm (Fig. S2). The schematic structures of the film were illustrated in the inset of the contours. If the period is smaller than 250 nm, the films showed low haze below 0.01% over the whole wavelength region. The structure allowed only zeroth-order of diffraction. On the contrary, the haze appeared when period is larger than 250 nm, haze is not zero. And the haze increased as period and height increased.

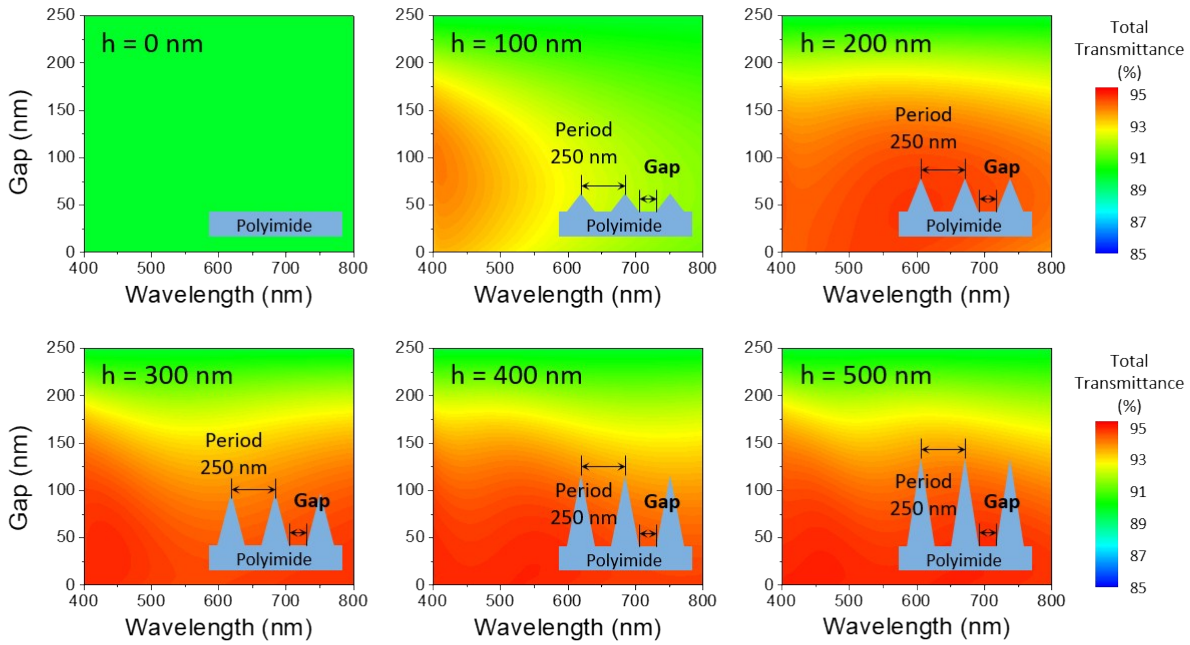

Fig. S3 (a) Calculated total transmittance (T_{total}) of the nanostructured plastic film as functions of gap and height of nanostructure. Period was set to be 250 nm.

The total transmittance of nanostructure plastic films ($n_{plastic}$ = 1.6) was calculated as a function of gap and height over the wavelength range of 400 nm to 800 nm (Fig. S3). The schematic structures of the film were illustrated in the inset of the contours. When the height = 0 (bare film), the total transmittance of the film was 89.6% over the whole range of the visible wavelength. The total transmittance was maximized at the low gap and high height. The structure could provide a more graded refractive index, so high transmittance was achieved.

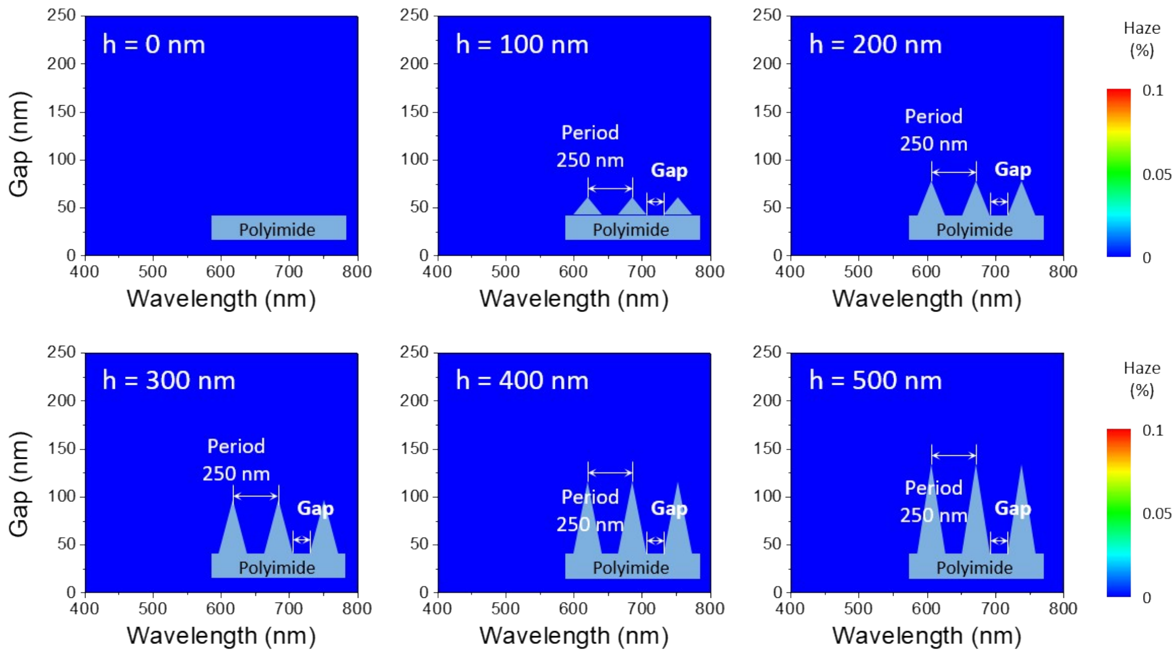

Fig. S4 (a) Calculated haze (*H*) of the nanostructured plastic film as functions of gap and height of nanostructure. Period was set to be 250 nm.

The haze of nanostructure plastic films ($n_{plastic}$ = 1.6) was calculated as a function of gap and height over the wavelength range of 400 nm to 800 nm (Fig. S4). The schematic structures of the film were illustrated in the inset of the contours. For all height and gap, the haze of the film was 0 % over the whole range of the visible wavelength because the period of nanostructure was set to be 250 nm which satisfies the haze-free condition.

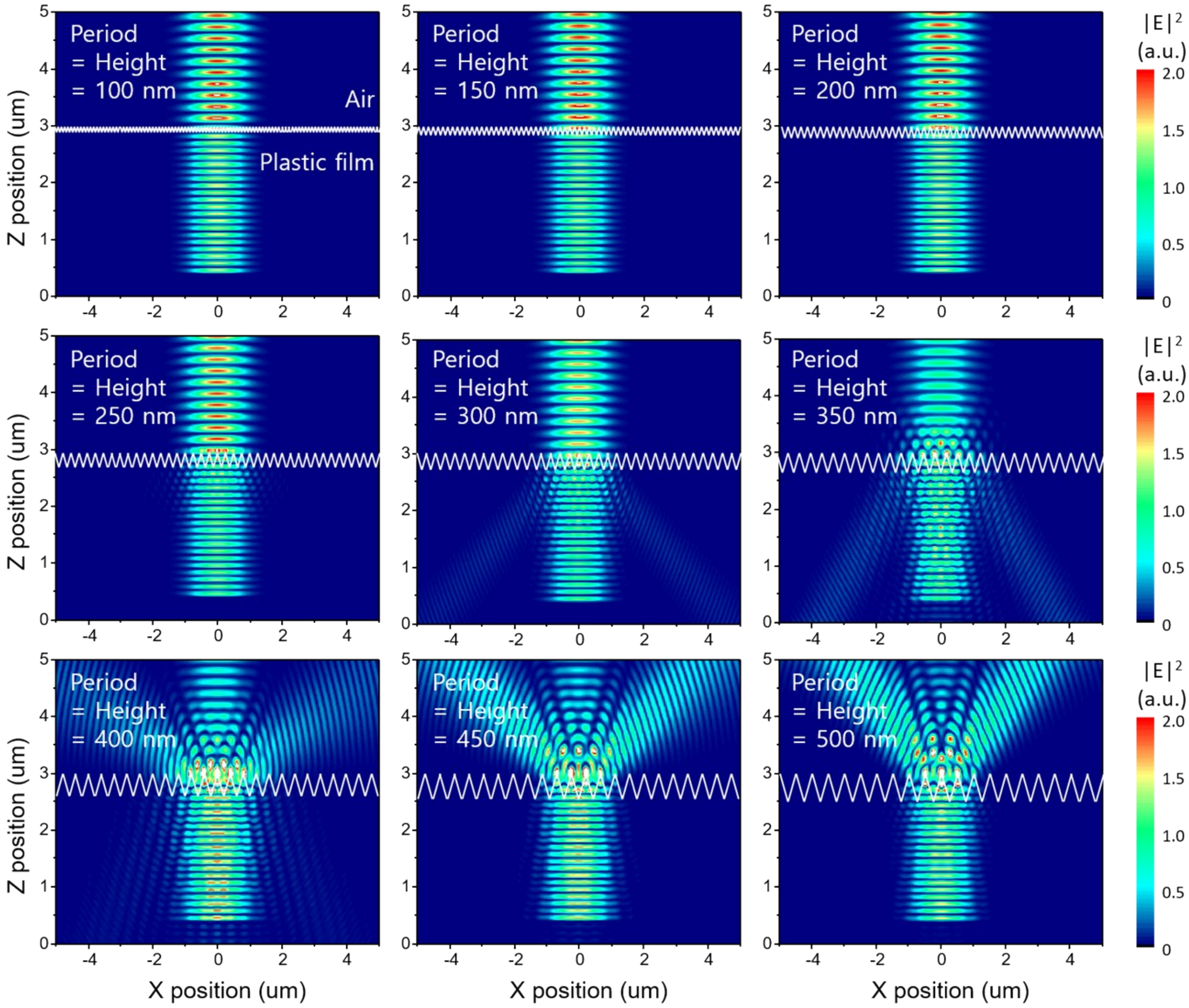

Fig. S5 Cross-sectional electric field distribution as a function of period of the nanostructure. Height was assumed to same as period.

Cross-sectional electric field distributions were calculated as a function of the period of the nanostructure (Fig. S5). Gaussian plane wave was excited from PI film to Air. Height was set to be same as the period. When period is smaller than 250 nm, the light propagated the structure straightly with high intensity of electric field. The reflected light was began to be scattered after the period > 300 nm. The transmitted light was began to be scattered after the period > 400 nm.

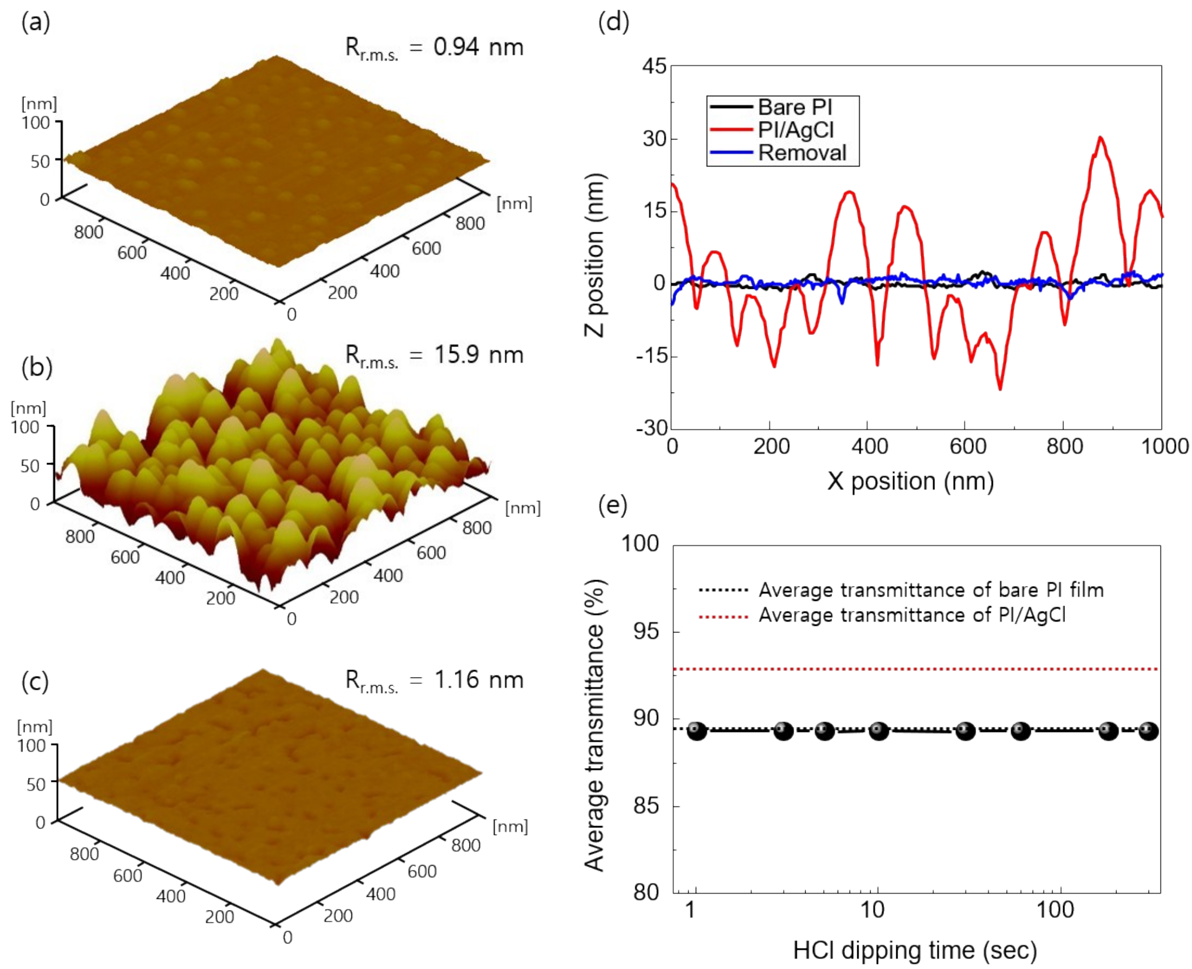

Fig. S6 (a) Atomic force microscopy (AFM, side view) images of (b) AgCl (t_{Ag} = 10 nm) and (c) after removal of the AgCl (dipping in HCl 1 sec). (d) Depth profile of those films. (e) Average total transmittance of bare PI film, AgCl nanostructure on PI film, and after removal of Ag as a function of dipping time in HCl measured by AFM. (e) The average total transmittance of the PI film, AgCl nanostructures implemented PI film, and AgCl removed PI film as a function of dipping time in the HCl.

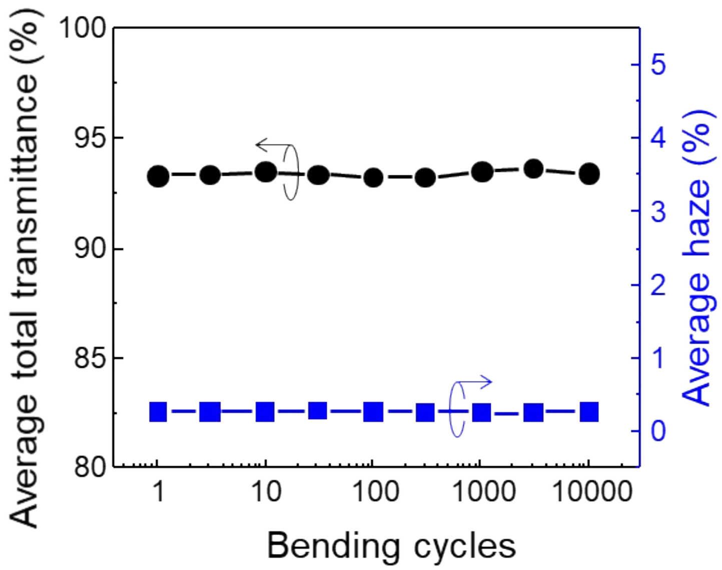

Fig. S7 Average total transmittance and haze of AgCl nanostructure on PI film as a function of bending cycles with bending radius of 2 nm.

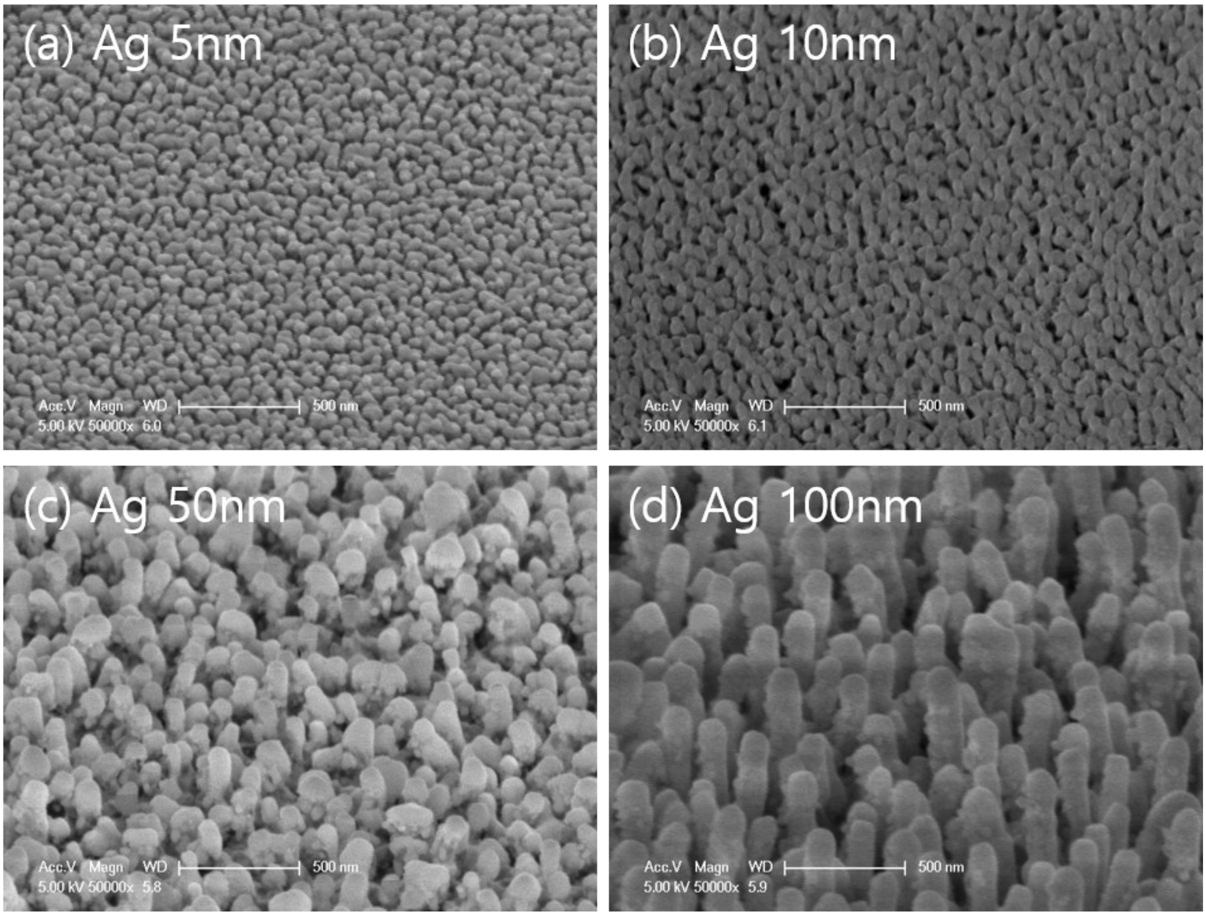

Fig. S8 (a) Scanning electron microscopy (SEM, 45° tilt view) images of the AgCl nanostructure with different Ag thickness (a) 5 nm, (b) 10 nm, (c) 50 nm, and (d) 100 nm. Cl_2 plasma treatment time was 45 s.