Supporting Information

Nano-structured hybrid-material transparent surface with antireflection properties and a facile fabrication process

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The height of the dewetted nanoparticles and the thickness of the spin coated polyimide are fundamental factors to create the nanostructures successfully and also to determine the depth of the cavities. As it can be seen in Figure S1, in these two samples, the spin coating and the PI solution were different, having different thickness. Therefore, one of the samples have the nanoparticles fully covered and the other not. After the same etching process, there was visual evidence that some copper remained under the PI in one of them. Due to its chemical resistance, PI can act as a barrier for the etchant and protects the copper particles that remain fully covered. From scanning electron microscope (SEM) analysis two different sample conditions can be seen: (i) sample where the spin-coated polyimide defined a thicker film creating a protective cover that prevented the dewetted copper from etching. In these regions, the nanoholes were not created successfully. (ii) sample where the polyimide had evolved to create a thinner film showed well-formed nanostructures free of metal after the etching step. However, both parts had the same distribution (either of holes or copper nanoparticles), demonstrating that the chemical etching of the nanoparticles creates the holes on the surface.

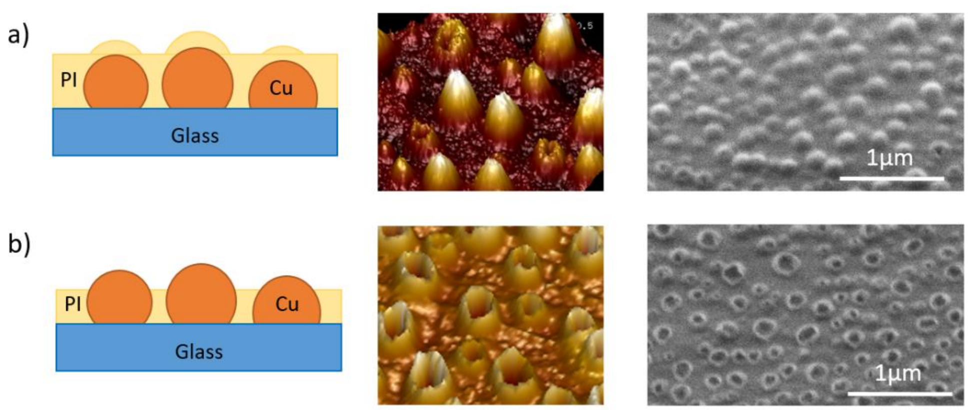


Figure S1. Process control. Too small (low) dewetted Cu nano-particles remain embedded inside the polyimide (PI) film and cannot be removed (a). Appropiate nanoparticles allow polyimide removal and formation of nano-holes (b).

Finite Element Method commercial software (COMSOL Multiphysics ®) was used to perform electromagnetic simulations. Figure S2. a) shows the final geometry model used to simulate the nanostructured polyimide. A square cell with a centered cavity was used with periodic boundary conditions. Figure S2. b.1) and b.2) represents the refractive index used for SiO2 and the Polyimide.

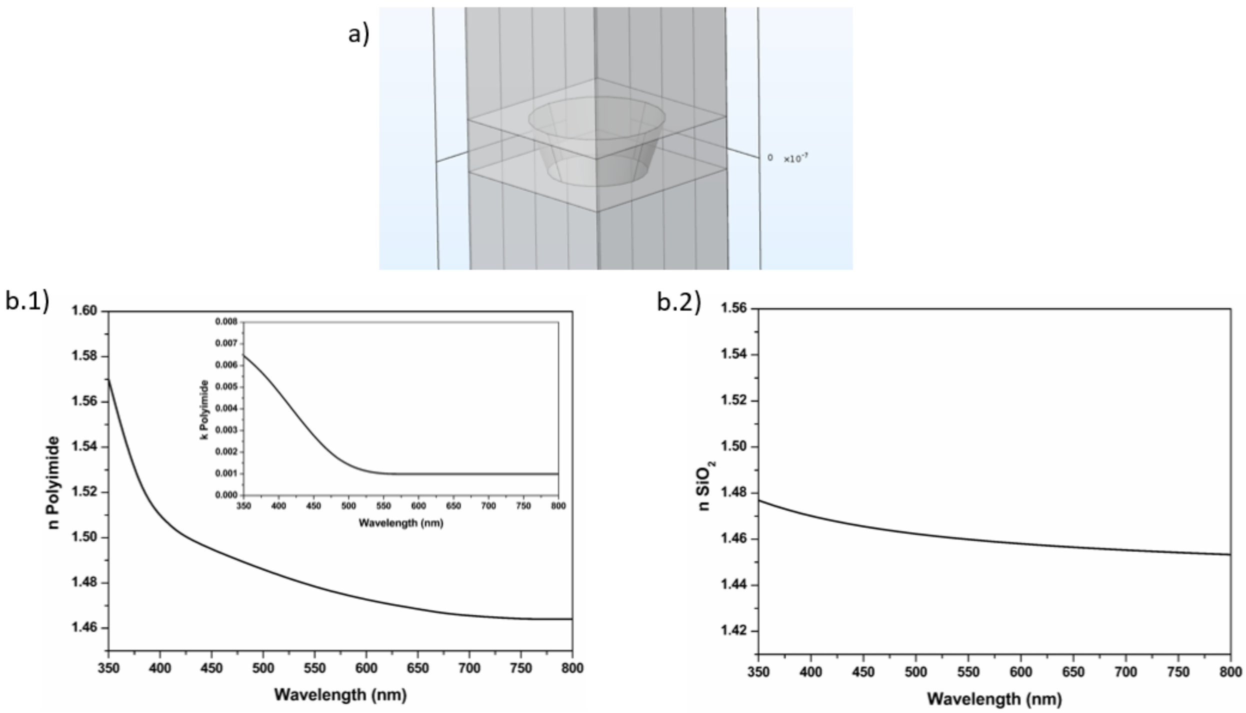
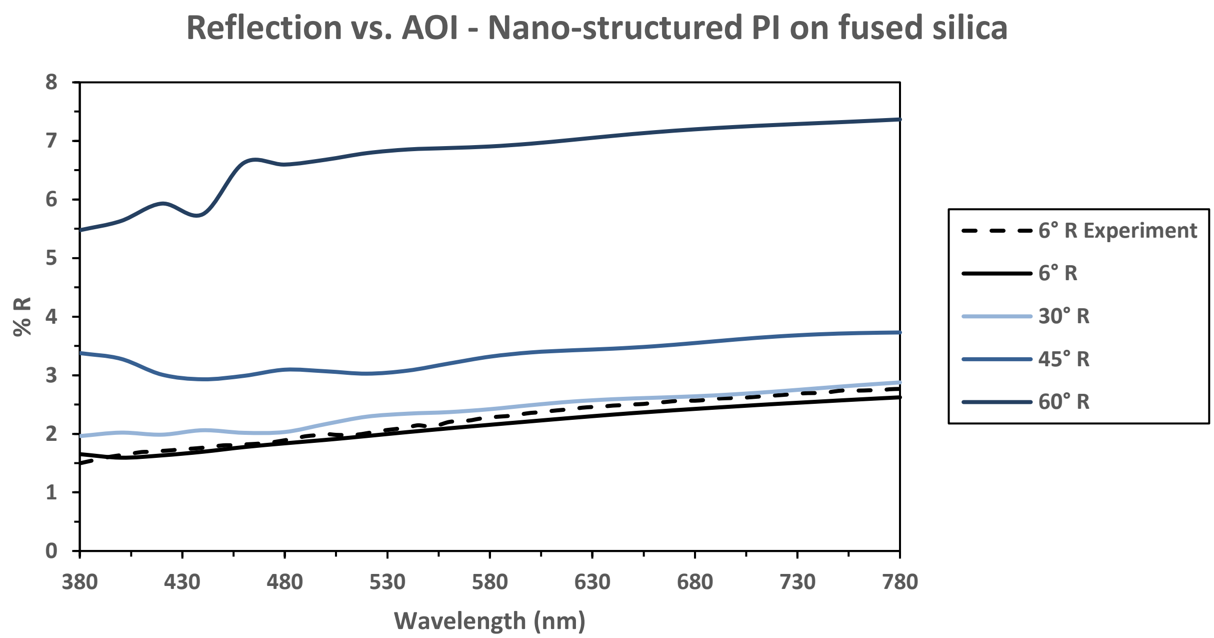


Figure S2. Nanocavity structure simulated with COMSOL Multiphysics ® software (a). The shape is a close approximation of the hole left after removal of the dewetted nano-particle. Refractive index and absorption coefficient (inset) of polyimide (b.1) and fused silica substrate (b.2) used in the simulations.

Figure S3 shows the simulated angular dependence of the AR response of the nanostructured PI film on fused silica substrate and ITO on fused silica substrate. Finite Element Method commercial software (COMSOL Multiphysics ®) was used to perform electromagnetic simulations. The nano-hole geometry in the simulation was the same as that presented in Figs. 2 and 3 of the manuscript.



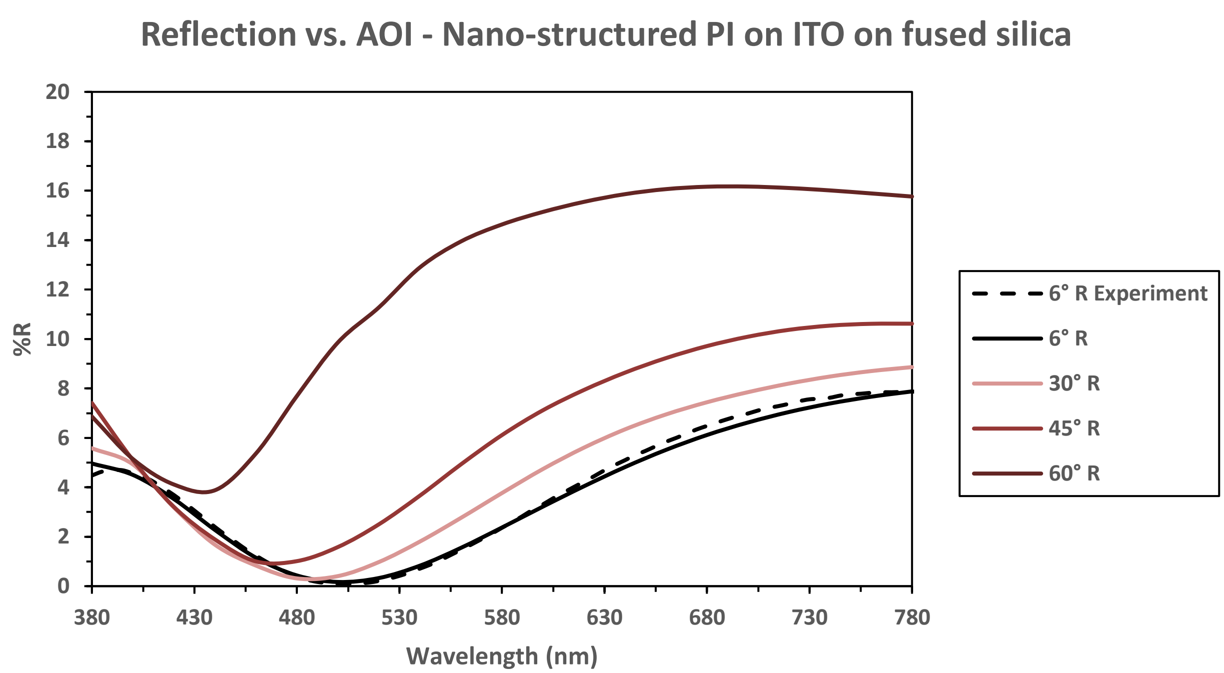


Figure S3. Simulated angular dependence of the AR response with COMOSL Multiphysics ® software of the nanostructured PI film on the fused silica substrate and ITO on fused silica substrate. One-side reflection for different angles of incidence, AOI (6°, 30°, 45° and 60°). Note that graphs in figs. 2 and 3 of main manuscript also included the flat back-side reflection. Experimental graphs at AOI=6º are also added showing good agreement between simulations and experiments. Materials indices were same as above for fused silica and PI (fig. S2) while for ITO were taken from Filmetrics database (https://www.filmetrics.com/refractive-index-database/ITO/Indium-Tin-Oxide-InSnO).

Scanning electron microscope (SEM) tilted views of the proposed structure (nanostructure PI on glass) is shown in the figure S4.

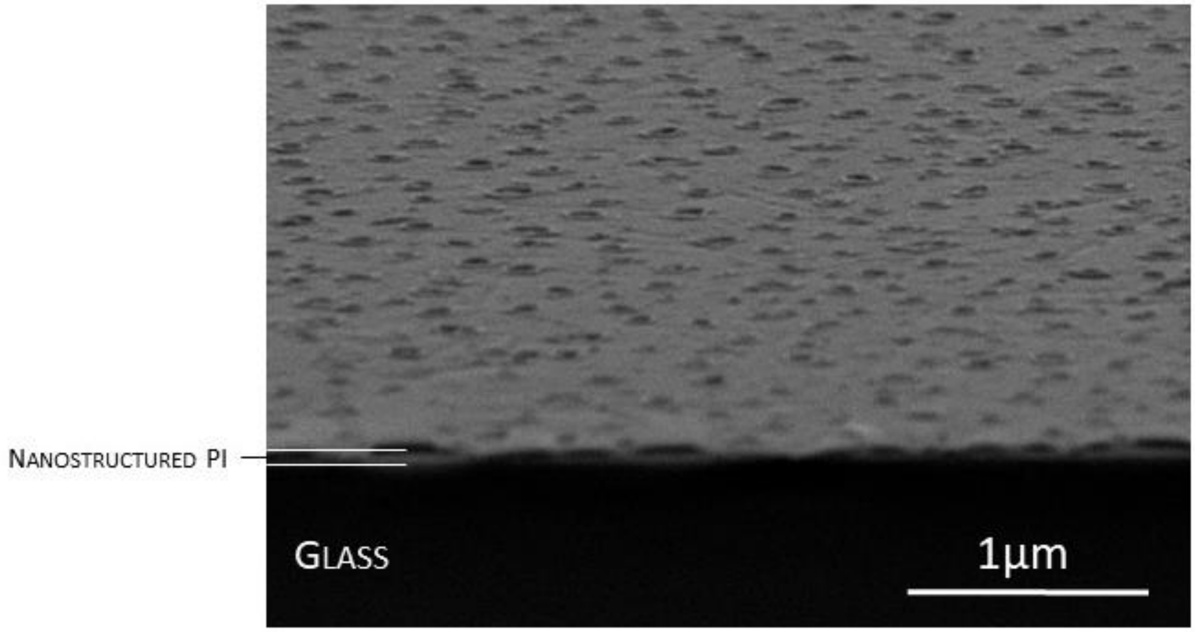


Figure S4. SEM tilted images of one of the optimized nanostructured PI film on silica substrate (sample similar to that of Figure 2 and 4). Note that the nanoholes are not completely clear due to electron charging.