Supplementary Information for

Preparation of mechanically stable triple-layer interference broadband antireflective coatings
with self-cleaning property by sol-gel technique

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Study of films’ chemical composition and degree of condensation by FT-IR spectral analysis

As shown in figure S1, the SiO<sub>2</sub> film and the SiO<sub>2</sub>-TiO<sub>2</sub> composite film have two absorption bands at 1060 and 791 cm<sup>-1</sup> that are typical of silica from the sol–gel process. These bands are attributed to the Si–O–Si asymmetric stretching and symmetric stretching absorption bands, respectively. The two samples also exhibited an absorption band near 953 cm<sup>-1</sup>, which is assigned to Si–OH or Si-O-C groups. The band at 1164 cm<sup>-1</sup> corresponding to the C-H bending vibration, indicates the presence of -OC<sub>2</sub>H<sub>5</sub> groups. The broad bands between 400 and 800 cm<sup>-1</sup> associating with Ti–O–Ti network are distinct in TiO<sub>2</sub> film. The O-H stretching vibration absorption band at 3400 cm<sup>-1</sup> is observed in the spectra of all samples. This peak is attributed to –OH and the adsorbed H<sub>2</sub>O. Besides, an O-H bending vibration of water molecule is also observed at 1630 cm<sup>-1</sup> as KBr salt tablets are easy to absorb water.
The condensation process of SiO$_2$ is the Si-OH or Si-OR groups to form siloxane groups (Si-O-Si). Ratio of integrated intensity of Si-O-Si to Si-OH peaks at positions 1060 cm$^{-1}$ and 953 cm$^{-1}$ can indicate the degree of condensation$^1$.

Figure S2 shows the Gaussian peak fitting of the FTIR spectra for acid-catalyzed SiO$_2$ film; individual peaks were resolved for relative intensity calculation. After resolving individual peaks, the area under the peak was calculated toward their integrated intensity. Ratio of integrated intensity of Si-O-Si to Si-OH peaks at positions 1060 cm$^{-1}$ and 953 cm$^{-1}$ was calculated. Calculated ratio was found to be 2.9. In the case of base-catalyzed silica, the ratio is larger (4.9, figure S3). The relative increase in the peak integrated intensity ratio of base-catalyzed SiO$_2$ film shows an increase in formation of Si-O-Si. In other words, the degree of condensation for acid-catalyzed SiO$_2$ film is much lower than
base-catalyzed SiO₂ film.

Figure S2. Gaussian peak fitting of the FTIR spectra for acid-catalyzed SiO₂ coating; individual peaks were resolved.
Figure S3. Gaussian peak fitting of the FTIR spectra for base-catalyzed SiO$_2$ coating; individual peaks were resolved.

*Particle size and its distribution of acid- and base-catalyzed SiO$_2$ and TiO$_2$ sols*
Figure S4. Particle size and its distribution of acid-catalyzed SiO$_2$ sol, base-catalyzed SiO$_2$ sol and TiO$_2$ sol

Their PdI (polydispersity index) values are 0.38, 0.37 and 0.26 for acid-catalyzed SiO$_2$, TiO$_2$ and base-catalyzed SiO$_2$ samples, respectively. According to the Malvern specification, samples with PdI $\approx 0.2$ are considered to be monodisperse. These results indicate that these sols are all monodisperse.

*Study of the crystal structure of TiO$_2$ by XRD*
Figure S5. XRD patterns of TiO$_2$ powder after calcination for 2h at 400 °C.

Anti-fogging property of the triple-layer film

Figure S6. Digital image exhibiting antifogging properties of (a) uncoated and (b) the triple-layer film coated glass substrates.