Supplementary material

Growth and atomic oxygen erosion resistance of Al_2O_3-doped TiO_2 thin film formed on polyimide by atomic layer deposition

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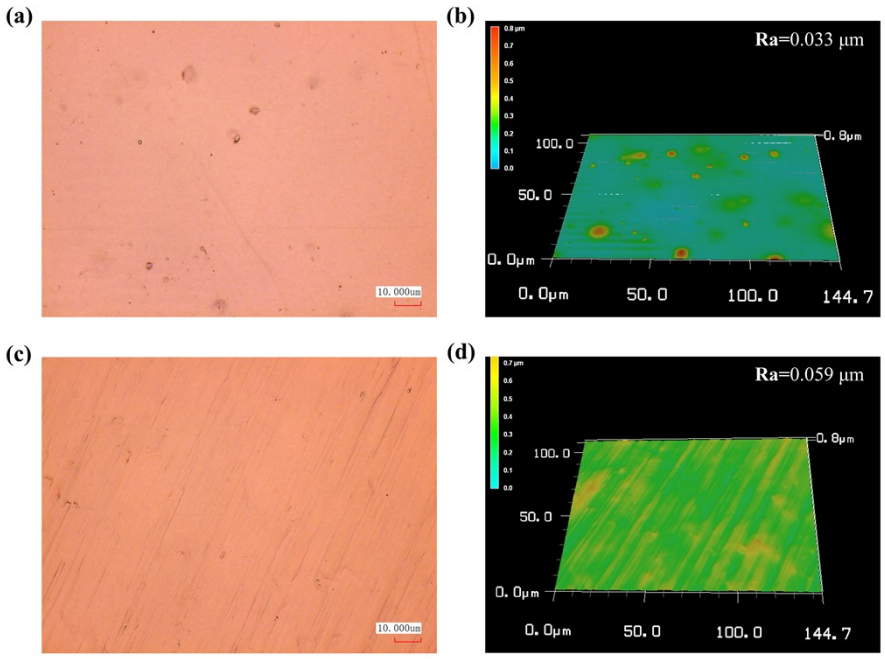

Figure S1. Optical microscope images of PI before and after NaOH activation:
(a) PI surface morphology. (b) PI 3D morphology.
(c) Activited-PI surface morphology. (d) Activited-PI 3D morphology.

FT-IR showed the chemical structures of the polyimide (PI) before and after alkaline activation (Figure. S2(a)). For example, the imide I band and II band are represented by the symmetrical and asymmetric stretching vibration peaks of the two carbonyl groups on the imine ring, which are found at 1776 and 1710 cm^{-1}, respectively. The imide III band and IV band are represented by the imide ring's C-N stretching vibration peak at 1369 cm-1 and vibration absorption at 720 cm^{-1}, respectively [1].

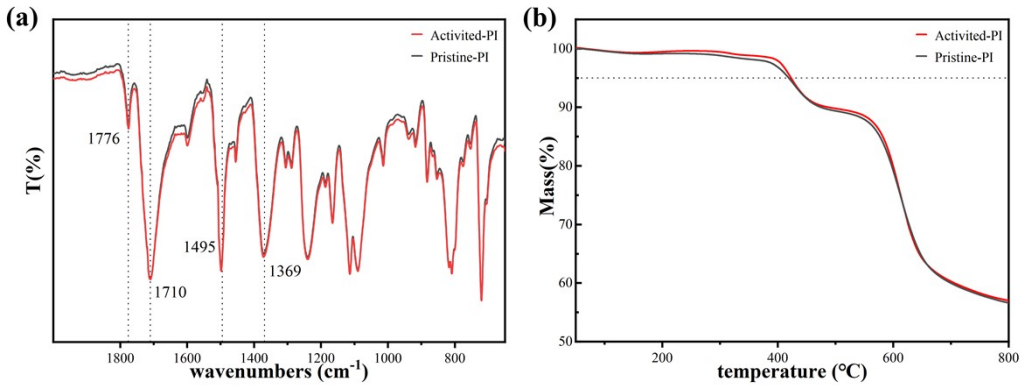

Figure S2. (a). The FT-IR analysis of PI before and after NaOH activation.

(b). The TG analysis of PI before and after NaOH activation

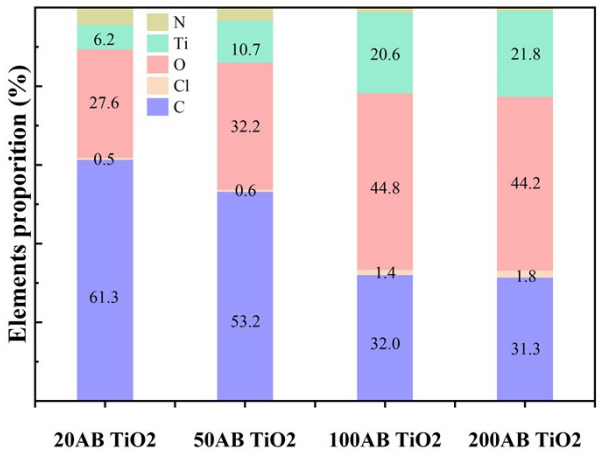

Figure S3. The Surface atomic proportions of PI after different ALD-TiO_2 cycles.

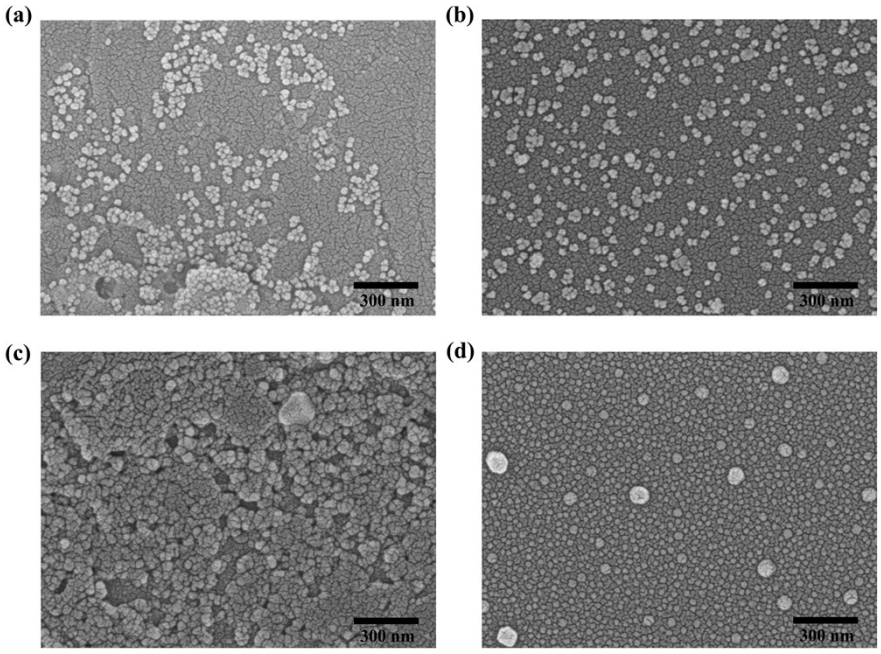

Figure S4. FESEM images of PI surface after different ALD-TiO_2 cycles:
(a) 20 ALD-TiO_2 cycles. (b) 50 ALD-TiO_2 cycles.
(c) 100 ALD-TiO_2 cycles. (d) 200 ALD-TiO_2 cycles.

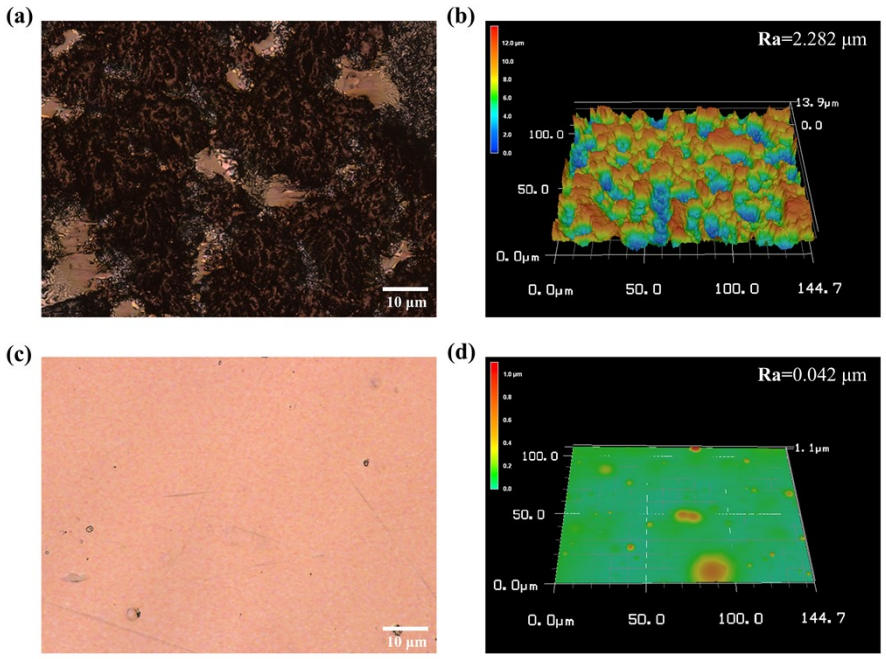

Figure S5. Optical microscope images of PI and of PI and 200AB ATO film coated PI after AO erosion:
(a) PI surface morphology. (b) PI 3D morphology.
(c) ATO@PI surface morphology. (d) ATO@PI 3D morphology.

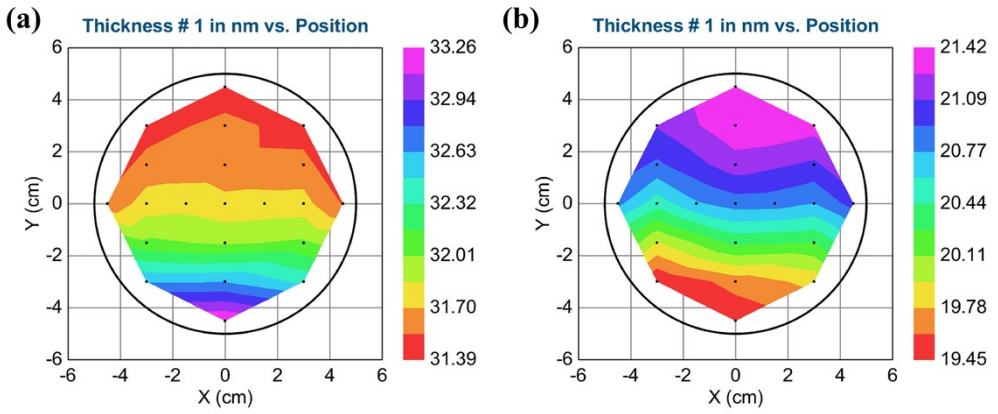

Figure S6. Thickness distribution of 300 ALD cycles films on the surface of silicon:
(a) 300 ALD-Al_2O_3 cycles. (b) 300 ALD-TiO_2 cycles.

The growth rate per cycle (GPC) at 100 °C is calculated by the growth thickness of Al_2O_3 and TiO_2 on the silicon wafer surface. As shown in Figure S6, after depositing 300 ALD cycles of Al_2O_3 and TiO_2, the average thicknesses measured by ellipsometry on silicon wafers were 31.88 nm and 20.61 nm, respectively. Therefore, the growth rate of Al_2O_3 and TiO_2 at 100°C on our equipment were calculated as 0.106 nm/cycle and 0.069 nm/cycle, respectively. This result provides guidance for the growth of ALD films on polyimide surfaces.

References

1. C.-P. Constantin, L. M. Gradinaru, O. Plopa and R.-D. Rusu, *Polymer Degradation and Stability*, 2022, DOI: 10.1016/j.polymdegradstab.2022.110036.