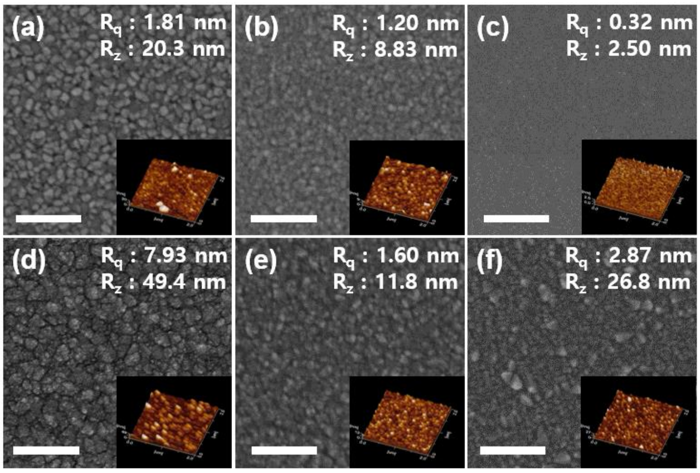

Fig 1. Surface morphology of (a) – (c) Ru electrode and (d) – (f) TiO_2 dielectric layers at the conditions of (a, d) Conventional ALD, (b, e) DFM-ALD, (c, f) Sputtered (scale bar: 200 nm).

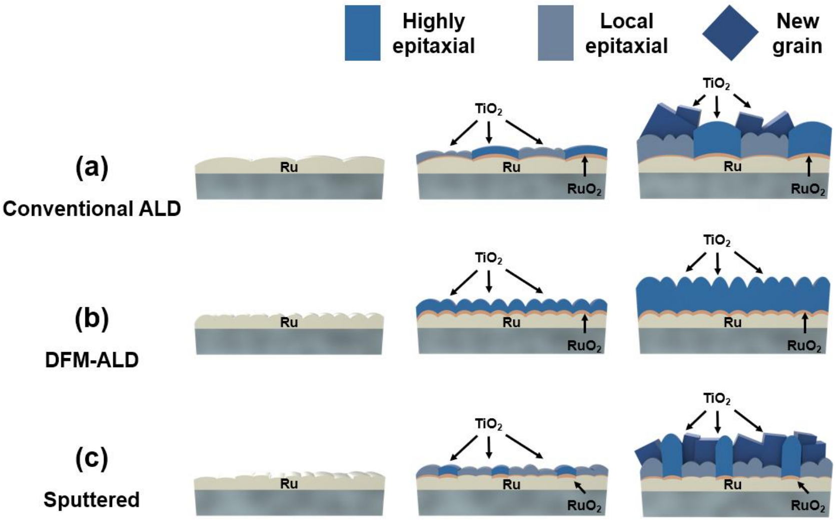

Fig 2. Schematic diagrams of the growth mechanism of the TiO_2 films with different Ru substrate conditions (a) Conventional ALD, (b) DFM-ALD, and (c) Sputtered.

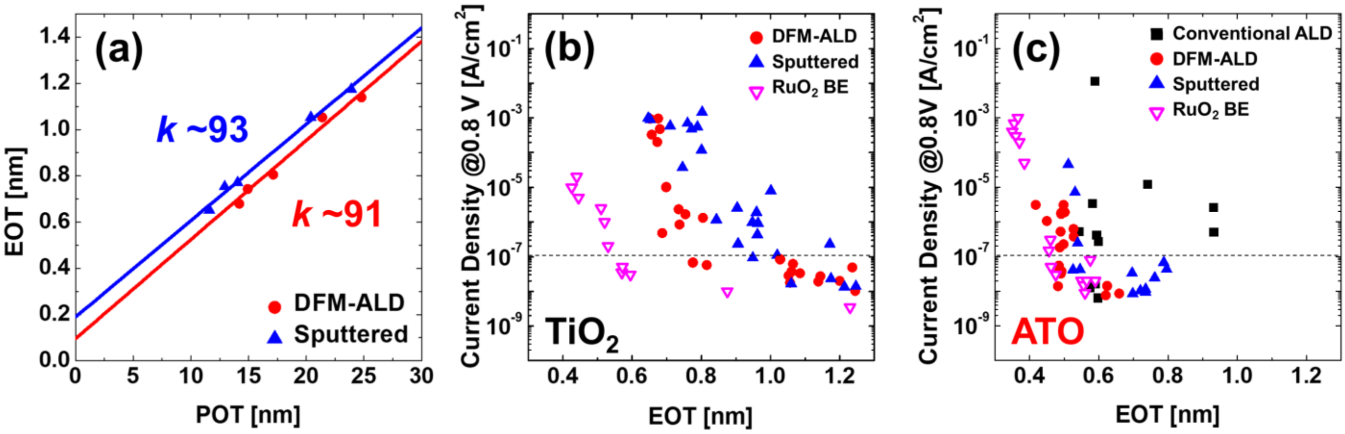

Fig 3. (a) EOT-POT graph of $Pt/TiO_2/Ru$ capacitor. (b) J-EOT curve of $Pt/TiO_2/Ru$ (RuO_2) capacitors. (c) J-EOT curve of Pt/Al-doped TiO_2/Ru (RuO_2) capacitors.