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Supplementary Information

High performance oxide thin-film diode and its conduction mechanism based on ALD-assisted interface engineering

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Conduction mechanism	Equation
Thermionic emission	$J = A^* T^2 exp(\frac{q\Phi_B - \Delta E}{k_B T})$
Fowler-Nordheim tunneling	$J_{FN} = \frac{\alpha(\beta V)^2 A}{\Phi_B d^2} exp(-\frac{bd\Phi_B^{3/2}}{\beta V})$ $ln(J/V^2) \propto K_1 1/V$
Ohmic conduction	$J = q\mu n_0 V$ $J \propto V$
Poole-Frenkel emission	$J = q\mu N_C E\left[\frac{-q(\Phi T - \sqrt{qE/\pi\varepsilon_i\varepsilon_0})}{kT}\right]$ $\ln(J/V) = \sqrt{V}$
Trap-free-SCLC	$J = \frac{9}{8}\mu_e\varepsilon_0\varepsilon_s\frac{V^2}{d^3}$ $J \propto V^2$
Trap-limited SCLC	$J_{SCLC} = \sigma_0$ $\left\{\frac{\varepsilon_0\varepsilon_i l sin\left(\frac{\pi}{l}\right)l^4}{q(l+1)B_c(2\alpha)^3}\right\}^l(\frac{2l+1}{l+1})^{l+1}(\frac{1}{d})^{2l+1}V^{l+1}$ $log(J) \propto K_2 log(V)$

Table S1. Equations for electronic conduction mechanisms in dielectric film.

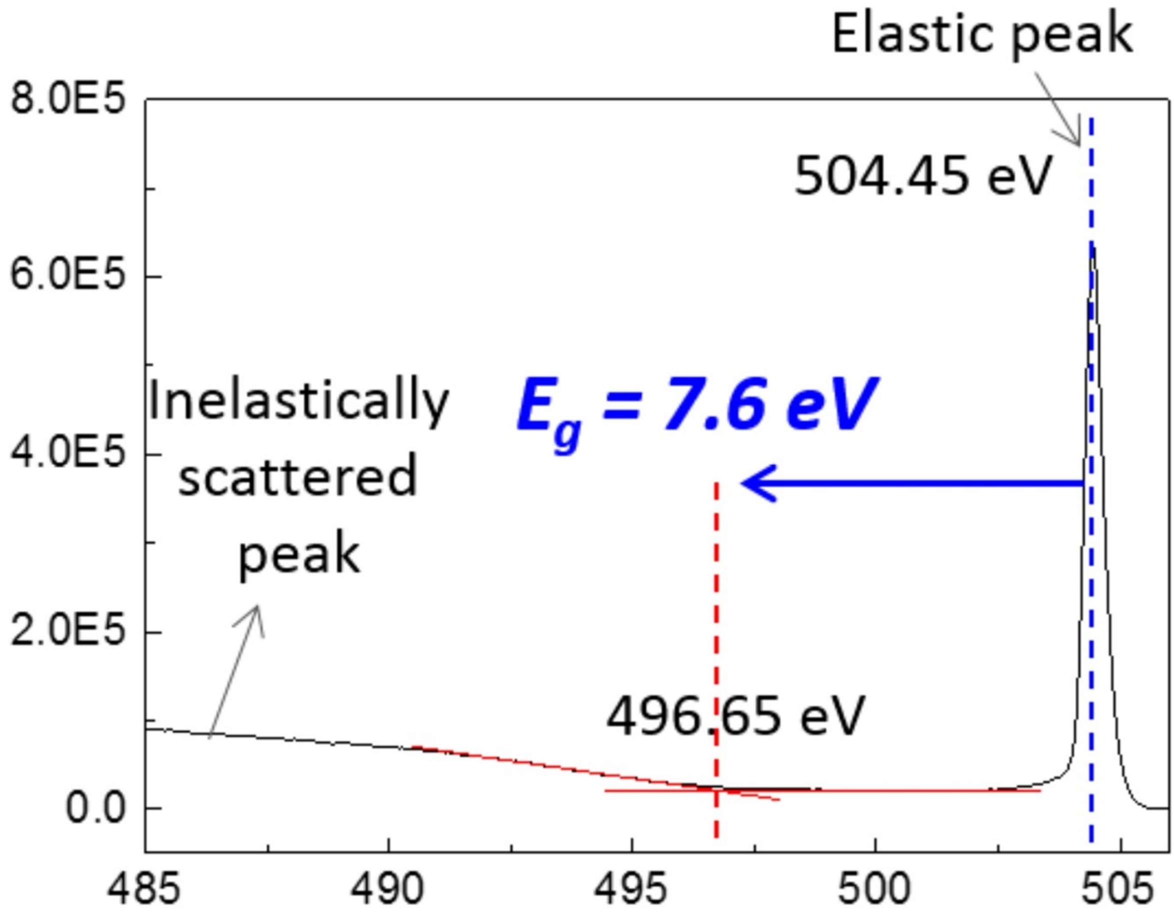

Figure. S1. Reflection electron energy loss spectroscopy (REELS) analysis of Al_2O_3. The calculated energy band gap is 7.6 eV.

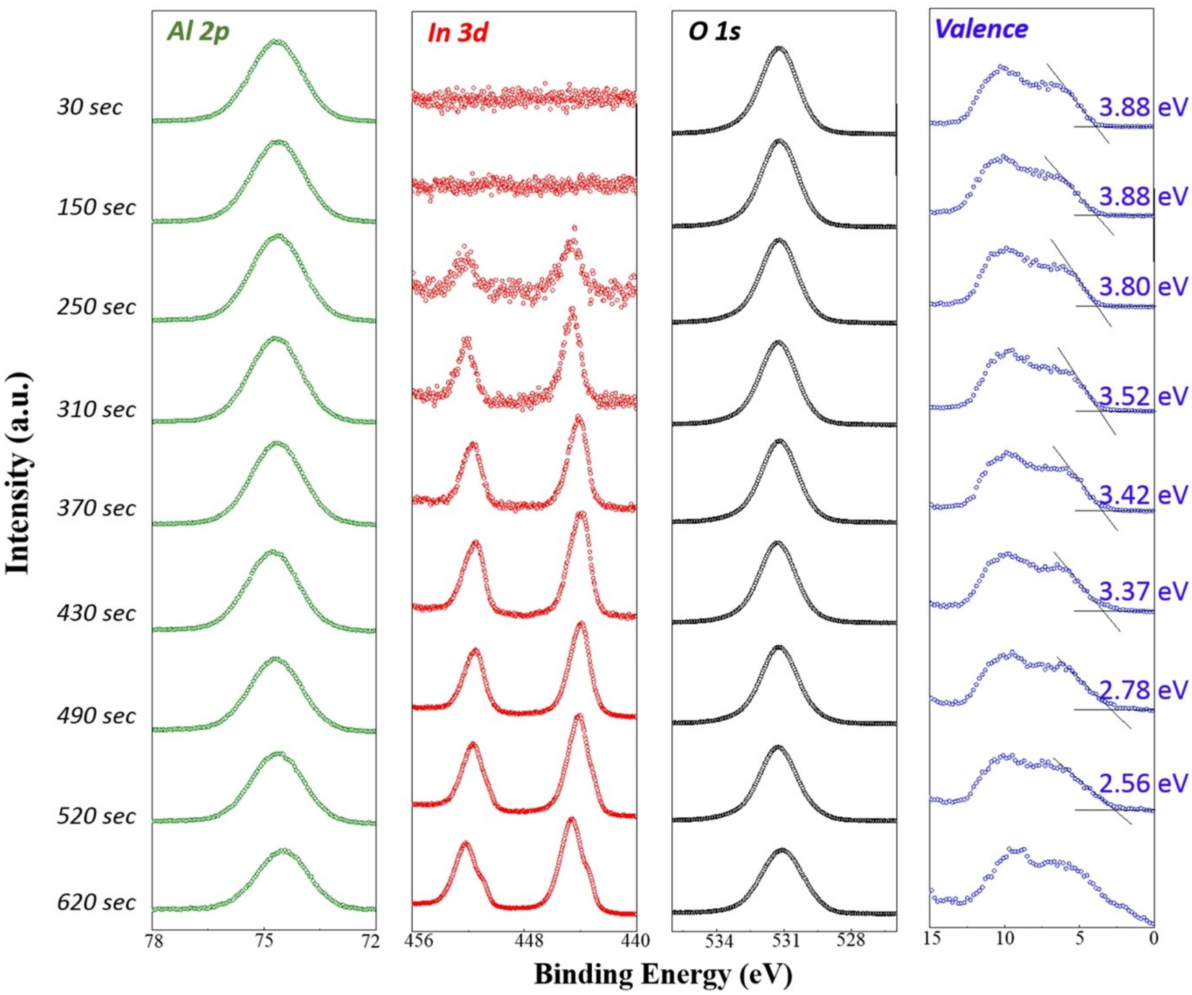

Figure. S2. Al 2p, In 3d, O 1s, and valence spectra for the IA (3nm-InO_x/20nm-Al_2O_3) stack as a function of sputter time for depth profile in X-ray photoelectron spectroscopy (XPS) analysis.

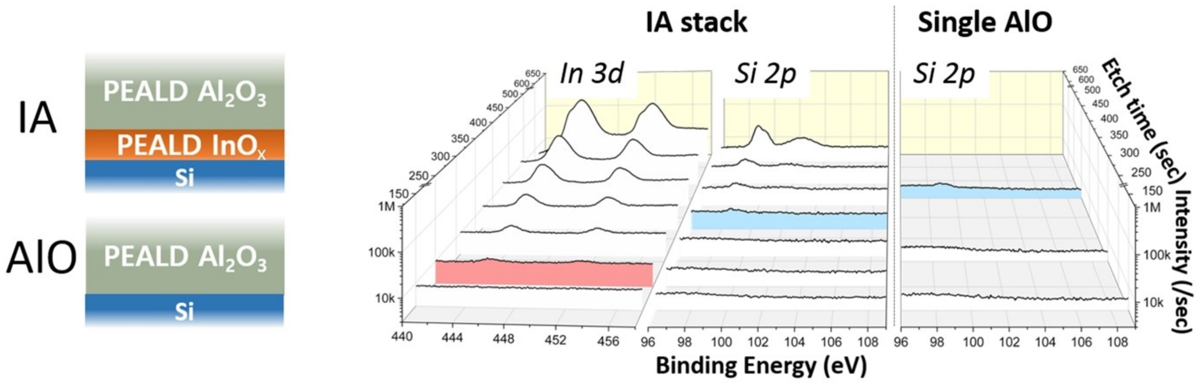

Figure. S3. X-ray photoelectron spectroscopy (XPS) depth profile of In 3d and Si 2p in IA (3nm-InO_x/20nm-Al_2O_3) stack, and Si 2p in 20nm-Al_2O_3 film on Si wafer.

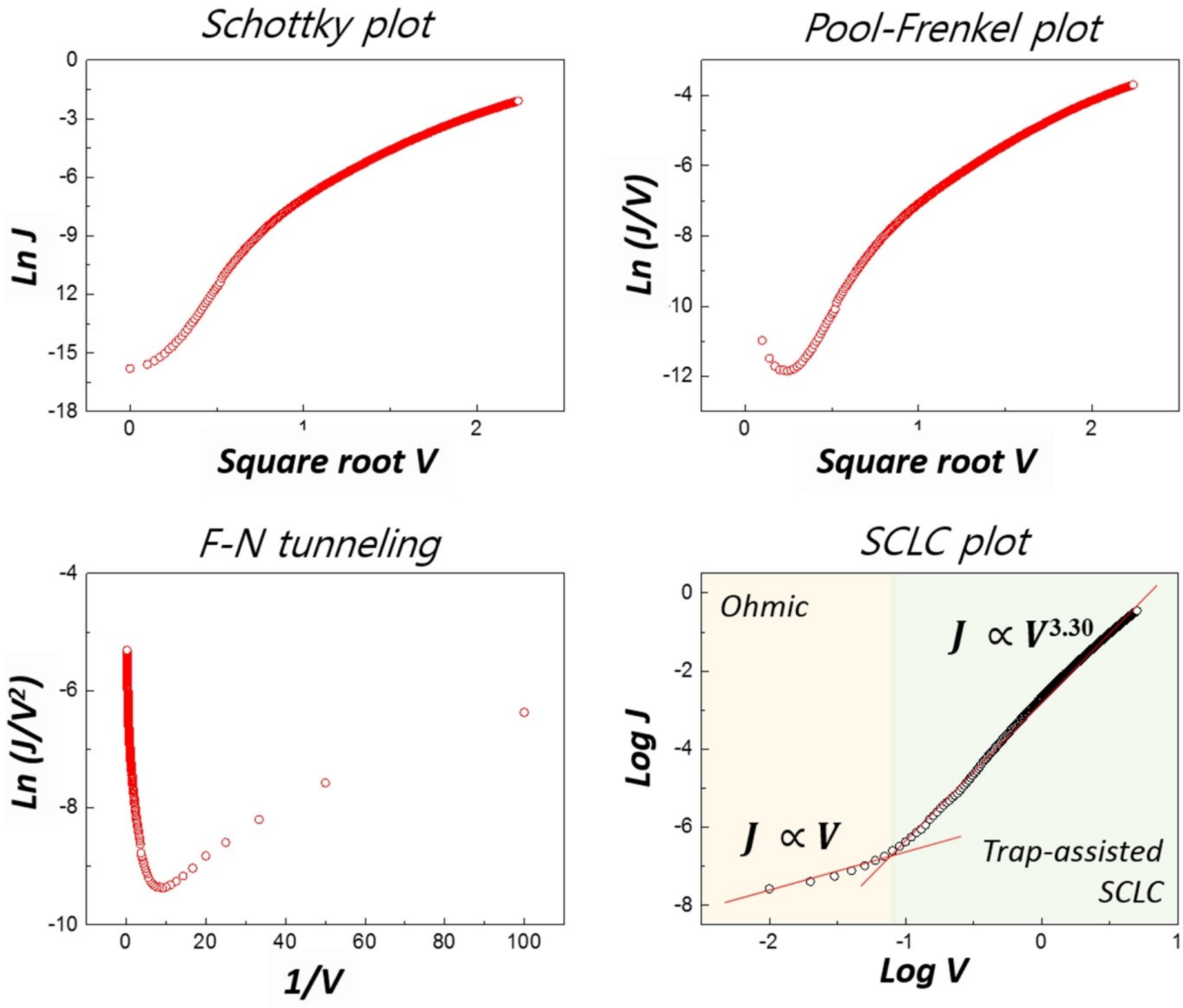

Figure S4. Fitting with various conduction models of the MSIM diode.

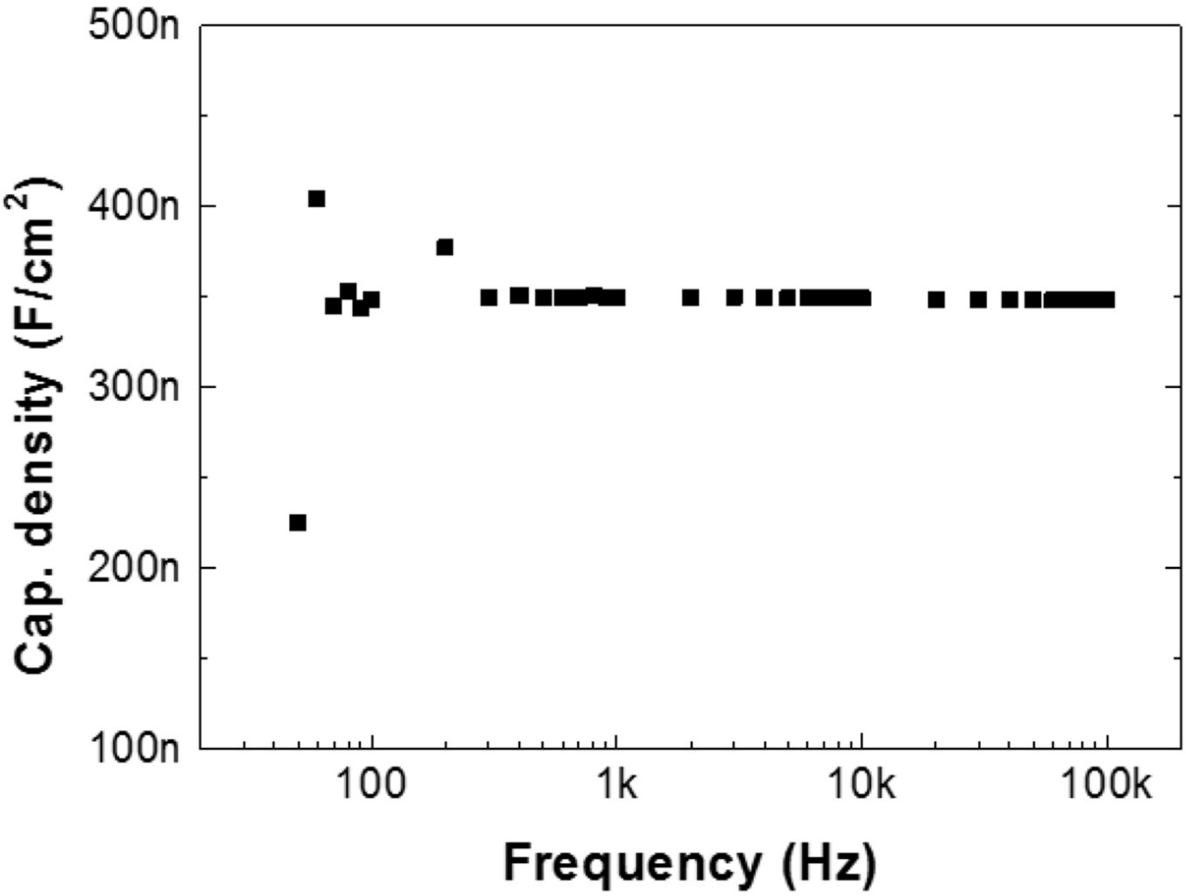

Figure S5. Capacitance–frequency curve of Al_2O_3 at applied DC voltage of –1V.

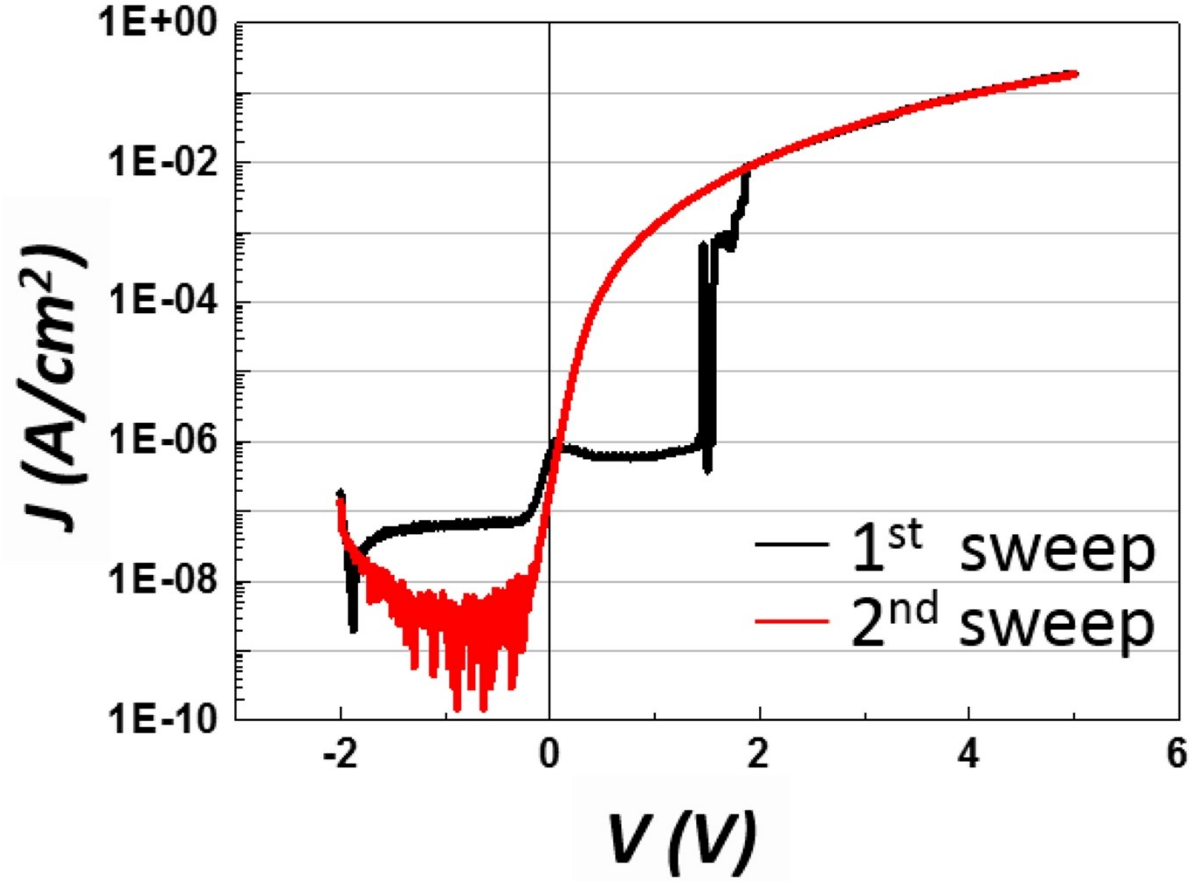

Figure S6. Wake-up effect of the MSIM diode. After the first sweep, the diode exhibited good rectifying characteristics.

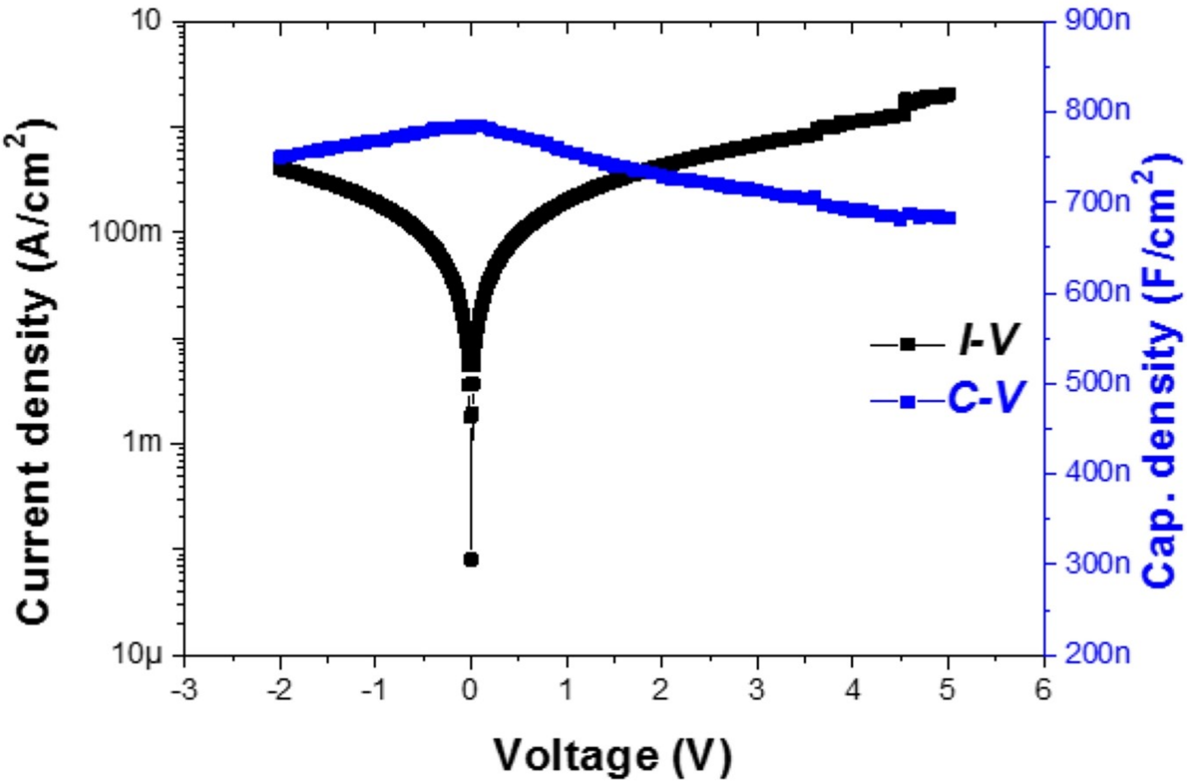

Figure S7. J–V characteristics of the MSIM diode using Al_2O_3 by thermal-atomic layer deposition (ALD).