Single film	Capacitance density	Breakdown field
600Å ALD HfO <sub>2</sub>	2555 pF/mm2	6.9 MV/cm
600Å ALD Al <sub>2</sub> O <sub>3</sub>	1444 pF/mm2	7.8 MV/cm
900Å PECVD Si <sub>3</sub> N <sub>4</sub>	645 pF/mm2	8.7 MV/cm

Table 1. Comparison of single film as capacitor dielectric with MIM capacitor deposited at 300C

Table 2. Four different laminate structures as capacitor dielectrics with  $HfO_2 + SiO_2$  that keep the same total thickness of  $HfO_2$  and  $SiO_2$ 

Laminate	Thickness (Å)	Total HfO <sub>2</sub> thickness	Total SiO <sub>2</sub> thickness
L3: HfO <sub>2</sub> +SiO <sub>2</sub> +HfO <sub>2</sub>	315Å+144Å+315Å		144Å
L5: HfO <sub>2</sub> +(SiO <sub>2</sub> +HfO <sub>2</sub> ) x 2	210Å+(72Å+210Å) x 2	630Å	
L9: HfO <sub>2</sub> +(SiO <sub>2</sub> +HfO <sub>2</sub> ) x 4	126Å+(36Å+126Å) x 4	030A	
L17: HfO <sub>2</sub> +(SiO <sub>2</sub> +HfO <sub>2</sub> ) x 8	70Å+(18Å+70Å) x 8		

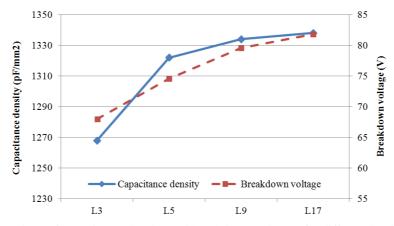


Figure 1. Comparison of capacitance density and breakdown voltage of 4 different laminate structures as MIM capacitor dielectric

## TDDB lifetime for MIM Cap, Ta=125°C 1.E+18 1.E+17 1.E+16 1.E+15 L9 1.E+14 $y = 3E + 13e^{-0.536x}$ 1.E+13 1.E+12 $y = 3E + 14e^{-0.597x}$ 1.E+11 1.E+10 LifeTime (sec) $y = 2E + 17e^{-0.903x}$ 20y'=6.3x108 s 1.E+09 L17 1.E+08 1.E+07 1.E+06 1.E+05 1.E+04 1.E+03 1.E+02 1.E+01 L3 1.E+00 0 15 20 25 35 55 70 5 10 30 40 45 50 60 65 Stress Voltage(V)

Figure 2. Comparison of TDDB lifetime measured at 125C. Extrapolation was applied to calculate lifetime at 20V after higher voltage stress. The lifetime of L17 capacitor at 20V is the shortest, but the breakdown voltage at room temperature is the highest.