Two-dimensional materials provide a versatile platform for various electronic and optoelectronic devices, due to their uniform thickness and pristine surfaces. We probe the superior quality of 2D/2D and 2D/3D interfaces by fabricating molybdenum disulfide (MoS2)-based field effect transistors having hexagonal boron nitride (h-BN) and Al2O3 as the top gate dielectrics. An extremely low trap density of $\sim 7 \times 10^{10}$ states/cm$^2$-eV is extracted at the 2D/2D interfaces with h-BN as the top gate dielectric on the MoS2 channel. 2D/3D interfaces with Al2O3 as the top gate dielectric and SiOx as the nucleation layer exhibit trap densities between $7 \times 10^{10}$ and $10^{11}$ states/cm$^2$-eV, which is lower than previously reported 2D-channel/high-k-dielectric interface trap densities. The comparable values of trap time constants for both interfaces imply that similar types of defects contribute to the interface traps. This work establishes the case for van der Waals systems where the superior quality of 2D/2D and 2D/high-k dielectric interfaces can produce high performance electronic and optoelectronic devices.

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The public is welcome to attend.