An atomically thin and high-k multi-functional oxide for electronic and opto-epectronic devices.

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The incorporation of high-*K* transition metal oxides improves the performance of the semiconductor devices which remains challenging due to the difficulties of the deposition methods.

In this work we show that the incorporation of the HfO_X by laser oxidation (with dielectric constant *k* ~15) into a wide range of van der Waals heterostructure (vdWh) devices such as flexible field effect transistors based on graphene, MoS_2 and WSe_2, resistive switching random access memories (ReRAM) and Light emitting and detecting quantum wells based ultra-thin HfO_x tunnel barriers leads to interesting electronic and optoelectronic properties.

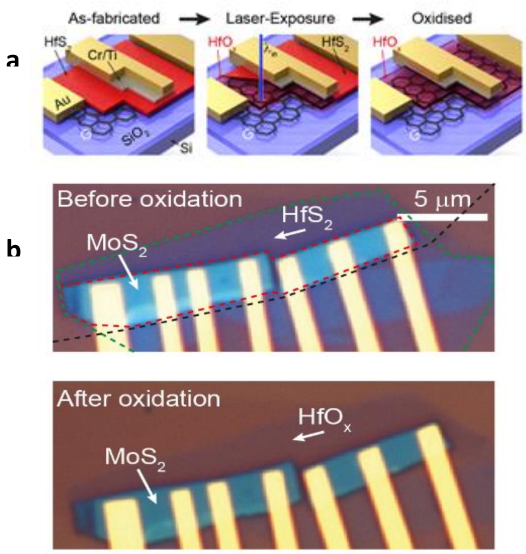

Figure 1. **Heterostructure processing route**. **(a)** The heterostructure is fabricated via dry transfer peeling from PDMS membrane (left), the area containing HfS_2 is exposed to laser light (centre) and the HfS_2 is converted into HfO_x (right).**(b)**Optical image of a Graphene/HfS_2/MoS_2 heterostructure before (top) and after (bottom) oxidation. Black outlines the region of the graphene back gate, green -outlines the HfO_2 and red the MoS_2.

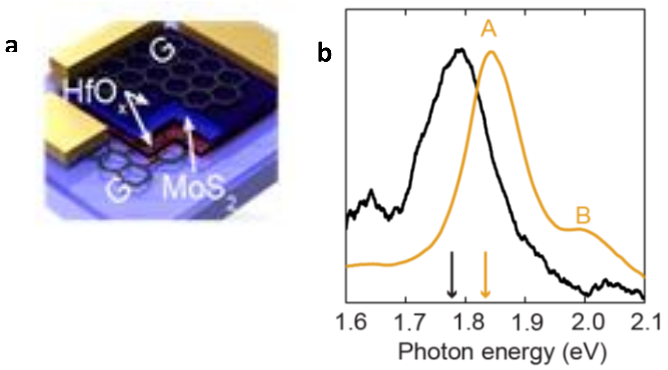

Figure 2. ***Thin HfO_x barriers for optoelectronic applications*** **(a)** Illustration of the device architecture. **(b)** El (black) and PL (brown) at *V_{sd} = 2.5 V and V_{sd} = 0V respectively.*