Increased WS_2 Crystal Grain Size by Controlling the Nucleation Behavior during Plasma Enhanced Atomic Layer Deposition

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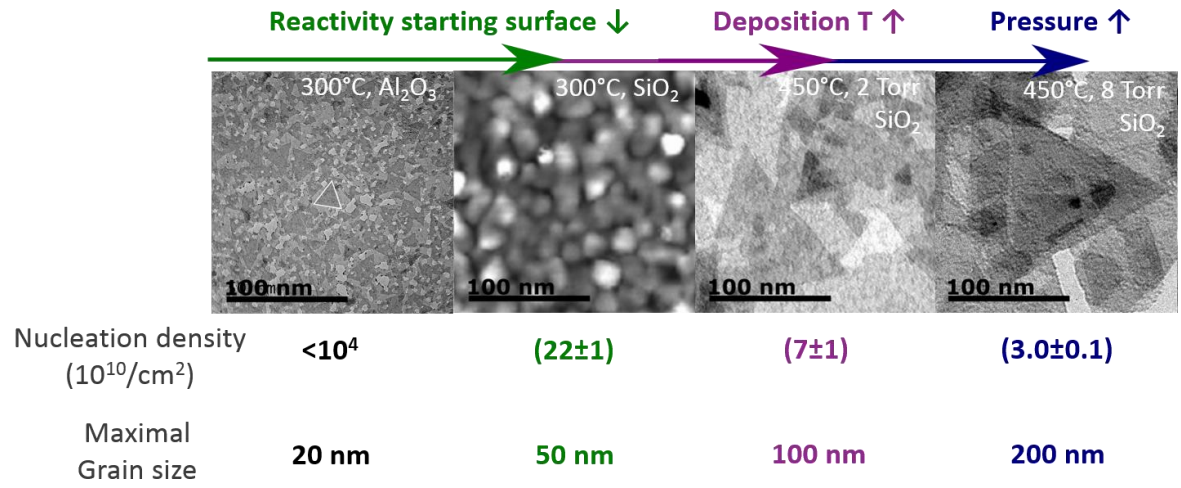

Figure 1. Evolution of WS_2 nucleation density and maximal crystal grain size with reactivity of starting surface, deposition temperature and reactor pressure, for an equivalent amount of deposited WS_2. The WS_2 is grown by PEALD from WF_6, H_2 plasma and H_2S on amorphous Al_2O_3 and SiO_2 starting surfaces at two different deposition temperatures (300 °C and 450 °C) and reactor pressures (2 Torr and 8 Torr), respectively. The micrographs reveal the crystalline structure of the as-grown WS_2 layers along the (0001) axis from plan-view transmission electron microscopy (300 °C, Al_2O_3 and 450 °C, SiO_2) and atomic force microscopy (only for 300 °C, SiO_2), respectively. Horizontal scalebar (inset) in each micrograph is set to 100 nm. The nucleation density and crystal grain size are extracted by analyzing the morphology of the WS_2 crystals for a series of atomic force micrographs during the nucleation phase of the PEALD process.