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## In-situ Growth of Epitaxial PbVO3 Thin Films under Reduction Atmosphere

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PbVO3 (PVO), a polar magnetic material considered as a candidate of multiferroic, has ferroelectricity along the c-axis and 2-dimensional antiferromagnetism lying in the in-plane through epitaxial growth [1,2]. PVO thin films were grown on LaAlO3 (001) substrates under reduction atmosphere from a stable Pb2V2O7 sintered target using pulsed laser deposition method. Epitaxial growth of the PVO films is possible only under Ar atmospheren with no oxygen partial pressure. X-ray diffraction was used to investigate the phase formation and texture of the films. We confirmed epitaxial growth of the PVO films with crystalline relationship of PbVO3[001]//LaAlO3[001] and PbVO3[100]//LaAlO3[100]. In addition, surface morphology of the films displays drastic changes in accordance with the growth conditions. Elongated PVO grains are related to the Pb2V2O7 pyrochlore structure. The relation between structural deformation and ferroelectricity in the PVO films was examined by local measurement of piezoresponse force microscopy.

**References**

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## Synthesis and Characterization of Large-Area and Highly Crystalline Tungsten Disulphide (WS2) Atomic Layer by Chemical Vapor Deposition

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Transition metal dichalcogenides (MoS2, WS2, WSe2, MoSe2, NbS2, NbSe2, etc.) are layered materials that can exhibit semiconducting, metallic and even superconducting behavior. In the bulk form, the semiconducting phases (MoS2, WS2, WSe2, MoSe2) have an indirect band gap. Recently, these layered systems have attracted a great deal of attention mainly due to their complementary electronic properties when compared to other two-dimensional materials, such as graphene (a semimetal) and boron nitride (an insulator). However, these bulk properties could be significantly modified when the system becomes mono-layered; the indirect band gap becomes direct. Such changes in the band structure when reducing the thickness of a WS2 film have important implications for the development of novel applications, such as valleytronics. In this work, we report for the controlled synthesis of large-area (∼cm2) single-, bi-, and few-layer WS2 using a two-step process. WOx thin films were deposited onto a Si/SiO2 substrate, and these films were then sulfurized under vacuum in a second step occurring at high temperatures (750$^{o}$C). Furthermore, we have developed an efficient route to transfer these WS2 films onto different substrates, using concentrated HF. WS2 films of different thicknesses have been analyzed by optical microscopy, Raman spectroscopy, and high-resolution transmission electron microscopy.

**Keywords:** Transition metal dichalcogenides, WS2