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The impact of O2/Ar ratio on morphology and functional properties in reactive sputtering of metal oxide thin films

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Abstract

Morphology is a critical parameter for various thin film applications, influencing properties like wetting, catalytic performance and sensing efficiency. In this work, we report on the impact of oxygen partial flow on the morphology of ceramic thin films deposited by pulsed DC reactive magnetron sputtering. The influence of O2/Ar ratio was studied on three different model systems, namely Al2O3, CuO and TiO2. The availability of oxygen during reactive sputtering is a key parameter for a versatile tailoring of thin film morphology over a broad range of nanostructures. TiO2 thin films with high photocatalytic performance (up to 95% conversion in 7 h) were prepared, exhibiting a network of nanoscopic cracks between columnar anatase structures. In contrast, amorphous thin films without such crack networks and with high resiliency to crystallization even up to 950 °C were obtained for Al2O3. Finally, we report on CuO thin films with well aligned crystalline nanocolumns and outstanding gas sensing performance for volatile organic compounds as well as hydrogen gas, showing gas responses up to 35% and fast response in the range of a few seconds.