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Rapid preparation of high quality alumina thin films by high power density reaction magnetron sputtering

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Introduction: Al_2O_3 thin films have been widely used in optical, microelectronics, mechanical and other fields because of its excellent optical properties, high mechanical strength, and corrosion resistance [1-2]. At present, there are many methods can be used to prepared Al_2O_3 thin films, such as magnetron sputtering deposition, pulsed laser deposition, ion-assisted deposition, chemical vapor deposition, sol-gel method, atomic layer deposition and so on [3-5]. Reaction magnetron sputtering is simple, scalable, and relative low temperature in depositing, while, it is limited by the deposition rate and the film quality due to the activity and poison of the Al target.

Materials and Methods: In this study, a magnetron sputtering cathode which can bear a very high power density (100~200 W/cm^2) is developed and the deposition window without target poison is broadened. The Al_2O_3 thin films were prepared on the soda-lime glass substrate by this magnetron sputtering cathode base with the most activity aluminum target (99.99%) and O_2 as reaction gas. The microstructure and morphology were studied by X-ray diffractometer (XRD) and scanning electron microscopy (SEM), the chemical composition was measured by X-ray photoelectron spectroscopy (XPS). Optical properties of the Al_2O_3 thin films were characterized by ellipsometer and ultraviolet-visible (UV-vis) spectrometer.

Results and Discussion: The results show that the oxygen flow and deposition rate are increased (Figure 1) with the increase of average power density, meanwhile the quality of the films is improved (Figure 2). The deposition rate of Al_2O_3 thin films reaches 70 nm/min when the distance between the substrate and the target is 45cm, which is more efficient than 10~20 nm/min of normal reaction magnetron sputtering with the distance between substrate and target is 10~15cm.

Conclusion: A high power density magnetron sputtering cathode is developed, and it can be introduced to rapid fabrication high performance Al_2O_3 thin films.

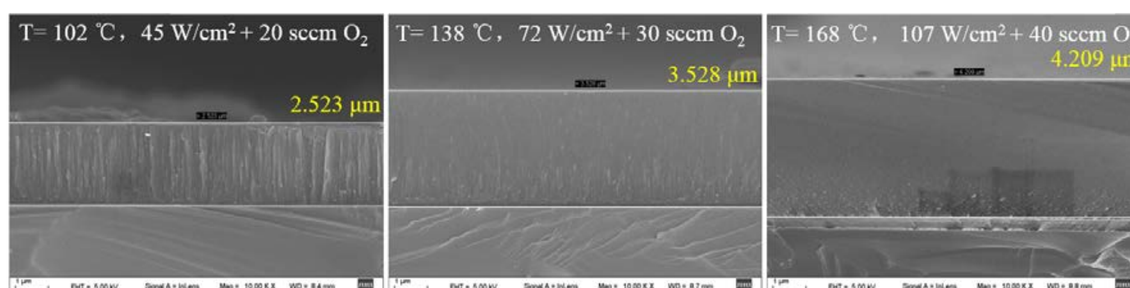

Figure 1 SEM images of Al_2O_3 films in different power density and oxygen flow, the deposition time is 1 h.

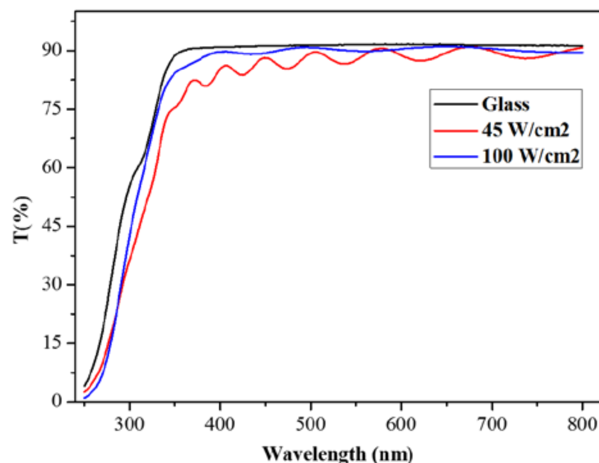

Figure 2 The transmittance of Al_2O_3 films in different power density

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