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Process optimization of AZO thin films with Al2O3 buffer layers prepared by RF magnetron sputtering

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The AZO (aluminum-doped zinc oxide) thin film, produced by coating on the flexible substrate, has many advantages such as light quality, rich resource, flexible and mass production. This paper presents an effective method for the parameters optimization for the deposition process for AZO thin films, using the Taguchi method, combined with grey relational analysis, and an L-9 orthogonal array was chosen for the experiments. The dependence of the structural, electrical and optical properties of transparent conducting AZO thin films with or without buffer layers deposited onto flexible polyethylene terephthalate (PET) substrates was compared. AZO thin films were prepared by radio frequency magnetron sputtering with an AZO ceramic target (2wt% Al2O3), by ranging sputtering power from 40 to 120W, working pressure from 0.5 to 3.0 Pa, sputtering time from 10 to 90 min, substrate temperature from 25 to 125℃. The results indicate that the thickness values of Al2O3 buffer layers have a large influence on the crystalline structures and photoelectric properties of AZO thin films. As the buffer thickness increased, the resistivity of AZO thin film decreased and the corresponding mobility increased, resulting from crystallinity improvement. The only (002) diffraction peak for the film is observed at 2 theta similar to 34.35 degrees, which shows that the films had a hexagonal ZnO wurtzite structure. The intensity of (002) peak decrease with increasing thickness of the Al2O3 buffer layer. The results show that compared with the sample without buffer layer, residual stress in samples with buffer layer of appropriate thickness reduced and the grain size increased. SEM images show that the surface is smooth and dense. The average transmittance of all AZO films in the visible range is about 80%. Four-point probe results show that the sheet resistance of AZO film with Al2O3 buffer layer has a significant decrease when compared with that of the single AZO film. All the results suggest that the insertion of Al2O3 buffer layer effectively improved the quality of AZO film on the PET substrate.

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