TRAJECTORY EFFECTS OF ATMOSPHERE PRESSURE PLASMA JET DEPOSITION ON THE PROPERTIES OF LARGE AREA ZNO THIN FILMS

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ABSTRACT: Large area (117 cm × 185 cm) gallium-doped zinc oxide (GZO) films have been prepared on glass substrates by atmosphere pressure plasma jet (APPJ) technique. The effects of scanning trajectory recipe (speed, pitch and number of passes) on structural and electrical properties of GZO thin films are investigated. We find that the trajectory has significant effects on the magnitude and uniformity of sheet resistance over the glass substrates. For single pass, distribution of sheet resistance data shows that the resistance appears higher near the region where the spray starts, whereas, for cases of multiple passes, the highest resistance appears in the central part of the substrate. Compared with sheet resistance, there is no correlation between scanning recipe and thickness distribution. Analysis of data obtained by XRD measurements shows that all the GZO films exhibit highly (002) orientation perpendicular to the substrate. SEM images show that larger grains appear more frequently near the end of spray. Two equivalent circuit models are applied to examine the distribution of sheet resistance for multilayer GZO thin films. We conclude that annealing time is the dominant root cause of the non-uniform resistance distribution, and other factors such as stress and structural characteristics may also have contributions. Therefore, the scanning trajectory must be carefully optimized with respect to those parameters in order to achieve a uniform resistance over a large area.

Keywords: transparent conductive oxide (TCO), gallium doped zinc oxide (GZO), atmosphere pressure plasma jet (APPJ), large area, sheet resistance.