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Crystalline structured ultra thin film synthesis by nano clusters deposition using 3D magnetic confined magnetron source

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This work reports an integrated approach, combined with an advanced magnetron and plasma diagnostic systems, utilized for the enhancement of the crystallinity, the carrier concentration, and the mobility of the ultrathin ITO thin films. For the requirement of flexible and transparent electrode applications, ultrathin films with superior crystallinity are necessary. However, demand and involvement of high deposition temperature and high temperature annealing often provide a limitation for the fabrication of the material as well as the deposition process. It is realized that ITO films with nanoclusters could be a useful tool for synthesis of high quality ultrathin ITO films. To increase the efficiency of nanoclusters generation, we create a very high density plasma environment by the design of magnetically confined rectangular magnetron source which is a novel highly confined 3-D magnetron source. The high ion density trapped by this source results in a very high sputtering rate of ITO species, which are localized inside the source and combined together to form cluster due to sufficient residence time. Further, due to weak diffusivity of neutral clusters, they do not reach the chamber walls during their motion in the flow. The flows of argon atoms in addition to the ITO clusters pass through this source regime and are deposited on a substrate. Overall, we have investigated the formation, growth and transport of nanosized ITO clusters in an advanced magnetron discharge and the deposition of these clusters on a substrate. Also the effect of different contributions such as electrons, positive ions, negative oxygen ions and deposition energy on the film growth and their properties are investigated by combining in-situ plasma diagnostics and ex-situ analysis.

Keywords
3D-confined magnetron sputtering
cluster deposition
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ultra thin film
trasparent and conductive thin film