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Understanding and using the current-voltage-pressure relationship in reactive magnetron sputtering for the growth of transparent conductive oxides

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Due to its inherent flexibility reactive magnetron sputtering is a very attractive technique for the fabrication of functional oxide thin films. Operating in the transition mode it is possible to grow stoichiometric materials with high deposition rates using cost-effective metallic targets. It is of utmost importance to reliably control the metal to reactive gas flux to the substrate in cases where the film composition plays an important role in achieving desired film properties. For example, this is the case in transparent conductive oxides based on ZnO and TiO_2, where small changes in the oxygen content in the films have a strong effect on their micro structure, optical and electrical properties.
Present work explores a method using the current-voltage-O_2 partial pressure relationship of the reactive magnetron discharge for this purpose. It is shown that there are two different groups of reactive discharges which can be classified by the ratio of the secondary electron emission coefficients of the metal and the corresponding oxide.
Each group shows a distinct current-voltage behavior, which demands a certain operation mode in order to stabilize the discharge in the transition mode. This enables a fine control of oxygen partial pressure resulting in optimized films. Model experiments linking discharge parameters with film properties will be discussed in detail.

Keywords
transparent conductive oxide
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zinc oxide
transition mode