OR1306

Optical and Electronical Properties of TiOx:Nb, Ta, Zr -Films, Deposited by Reactive Magnetron Sputtering from Metallic Targets

Rainald Mientus[1], Klaus Ellmer[2], Stefan Seeger[1], Michael Weise[1], Johanna Reck[1], Elisabeth Reck[1]

[1]OUT e.V., Berlin, Germany [2]Helmholtz-Zentrum Berlin, Berlin, Germany

mientus@out-ev.de

The last years have seen a growing number of investigations on titanium oxide doped with metals like Nb, Ta, Zr, Mo for its perspective use as a transparent conducting oxide (TCO). Especially its high chemical stability and abundance are the main advantages of TiO_2. High transparency (up to 90% in VIS Region) and low resistivity (> $3 \cdot 10^{-4}$ Ωcm) [1] make it an attractive candidate for substituting ITO, ZnO or SnO_2, the TCO's mostly used today. Recently, TiO_2:Nb was already applied as a window and contact layer in Cu(In,Ga)Se_2 solar cells, which were used for direct water splitting. Here, the high chemical resistivity of TiO_2 was the main aim for selecting this new TCO material [2].
The present work concerns the reactive magnetron sputtering of TiO_x films from metallic targets of TiNb (6wt%), TiTa (10wt%), TiZr (6wt%). Optical and electrical film properties are investigated in dependence on process parameters like oxygen partial pressure, substrate temperature and total sputtering pressure. Additionally the films have been annealed in oxidising and reducing atmospheres. Both, furnace annealing (up to 600°C) as well as flash lamp annealing (ms-region) are investigated. Special emphasis is paid to the optical analysis, i.e., spectral ellipsometry and reflection and transmission measurements. The maximum transmission in the visible spectral range is more than 90 %. The optical data are fitted to a physical model for band gap and free carrier absorption. The optically determined electronic parameters carrier concentration and mobility are related to the electrically determined values, obtained from Hall and conductivity measurements. The minimum resistivities achieved are $3 \cdot 10^{-3}$ Ωcm (carrier concentrations > 10^{21} cm^{-3} combined with mobilities < 5 cm^2/Vs).
[1] N. Yamada, et al., Thin Solid Films 518, 3101-4, 2010
[2] B. Neumann, et al., physica status solidi (b) 245, 1849, (2008)

Keywords
titanium oxide
niobium
tantalum
zirconium
reactive magnetron sputtering