Institute of Physics IA
SPUTTERING GROUP
Prof. Dr. rer. nat. Matthias Wuttig

Bachelor Thesis in Physics

Epitaxial growth of Ag(100) on MgO(100) and TiN(100) dielectric coatings for optical mirror applications

Low emissivity (low-E) glazing units save energy because they reduce the heat loss from a building through the windows. Low-E glazing systems use very thin layers of silver to reflect infrared energy contained in room back into the room while allowing the visible light transmission. Development in this technology combines advances in materials science, vacuum deposition techniques and optical design.

Emissivity is linked to the electrical conductivity of the silver thin film; an improvement of the conductivity of the silver film leads to decrease of emissivity. However, the electrical resistivity of silver when it is in bulk form, is not the resistivity of the very thin (~12nm) silver film, since its electrical resistivity becomes larger as its thickness decreases (Fig.1).

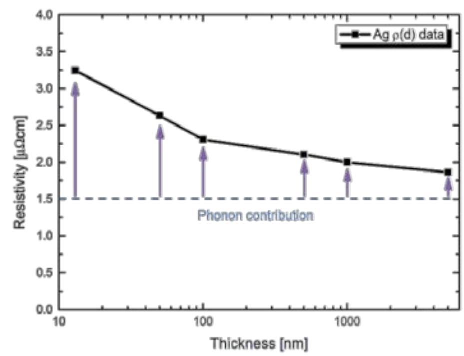

Figure 1. Resistivity for thin films significantly increased compared to bulk

The electrical and optical properties of metallic thin films critically depend on the surface morphology of the film and hence on nucleation and grain growth behavior. In order to obtain films with highly oriented grains and few defects, epitaxial growth of this film on a template layer with closely matched lattice constants is needed. MgO is very promising seed layer for Ag thin film growth due to the relatively small lattice mismatch of 2.98% between fcc Ag and rock salt MgO, and the resulting four-fold symmetric cube-on-cube epitaxy [1].

MgO films can be deposited biaxially textured (in out-of-plane and in-plane) via ion beam assisted deposition. Therefore, biaxial texture formation together with very similar in-plane lattice constants of Ag(100) and MgO(100), make MgO an excellent template layer for subsequent epitaxial Ag thin film deposition. However, Ag films shows island-like 3D growth on MgO seed layer due to the very similar surface energy values, which hinders electron transport and increases the Ag thin film resistivity due to the increased surface scattering of electrons.

The aim of this work is the investigation of the role of TiN(001) as an interfacial layer between Ag(001) and MgO(001). TiN layer is expected to lead layer-by-layer growth of Ag thin film yielding a lower defect formation and a smoother surface, since surface energy of TiN(001) is higher than both Ag and MgO layers. TiN has a rock salt structure (like MgO) and a relatively small lattice mismatch with Ag of 3.7% [2]. Therefore, represents a promising seed layer for Ag thin film growth.

Desirable skills for work:

- Experimental skills,
- Safe handling of Origin / Matlab or similar programs,
- Enthusiasm for scientific research and the ability to work in an industrial project,
- Good English skills.

[1] J. S. Chawla and D. Gall, Journal of Applied Physics, 111, 043708 (2012)
[2] C. S. Shin *et al*., Journal of Applied Physics, 95, 356 (2004)

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