Empa, Swiss Federal Laboratories for Materials Science and Technology

Laboratory for Joining Technologies & Corrosion

Master Project and/or Thesis

Investigation of AlN as a thermal barrier layer in PVD-nano-multilayered coatings

Multilayered architectures, which comprise a periodic alternation of different single- or multiple-elemental layers, are a versatile and promising route to tailor the properties and/or durability of functional materials in various application areas, such as those related to optical, magnetic, and electronic devices, tribology, nano-joining and mechanical engineering. The combination of nano-confinement and interfacial effects between a metal filler and a *barrier layer* in such nano-multilayered (NML) systems may be exploited to optimize specific material properties, such as mechanical strength, reflectivity, pre-melting or superheating behaviour and electrical conductivity. However, NML architectures are intrinsically thermodynamically unstable and typically exhibit large residual stresses, which may deteriorate their long-term stability under harsh operation conditions (e.g., elevated temperatures, complex loading conditions) [1,2,3]. In particular, the role of barrier layer is highly important in determining the final stability and performance of the NML. Thermal degradation and metal filler surface outflow can be tailored by tuning the internal stress, the individual layer thickness and the microstructure of the *barrier layer*. **In this master thesis, we propose a systematic investigation of the AlN barrier layer in Ag/AlN multilayers opportunely prepared by PVD sputtering. Different AlN microstructures with various internal stress states will be obtained by changing the deposition conditions during the growth and properly characterized by XRD and SEM as main techniques**. The effect of the AlN morphology, microstructure and internal stress on the Ag surface outflow and NML thermal stability during post-annealing will be studied and related to the tuned AlN barrier microstructures.

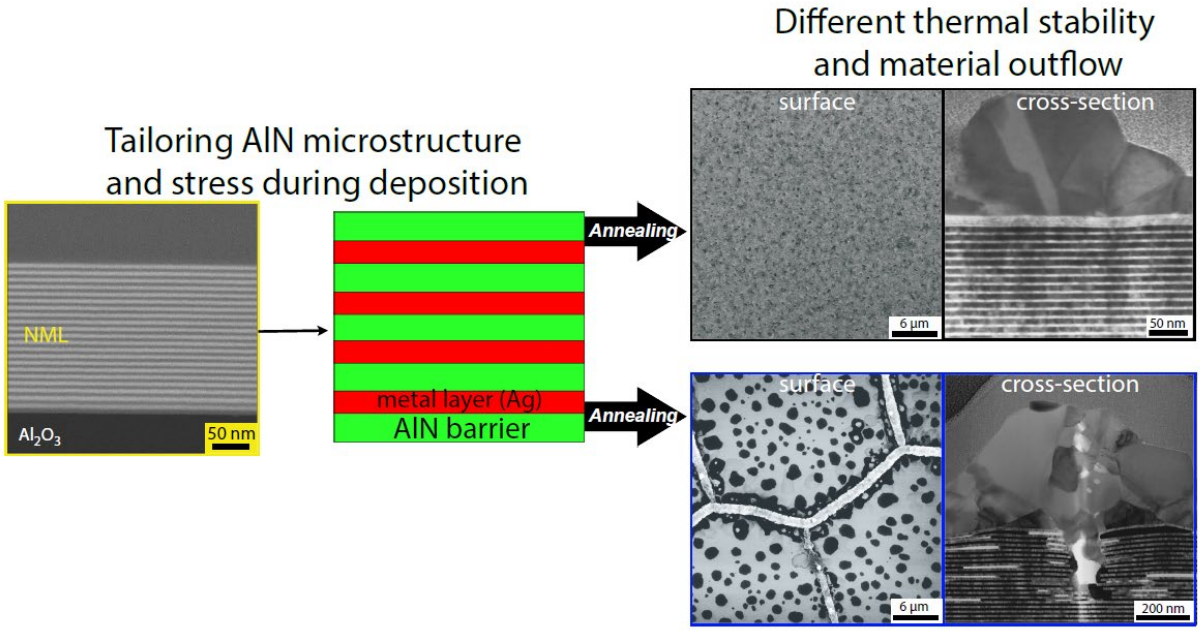

Figure 1: Schematic of the master thesis proposal: from the growth of different AlN microstructures to the thermal stability upon heating: different behaviours are expected (based on the work in [1,3]).

Scope of the thesis

The thesis involves: (a) aspects of PVD process technologies, (b) extensive structural analysis by XRD, (c) detailed characterization of surface properties by SEM, (d) use of high temperature furnaces. Duration: 6 months (master thesis). We are looking for motivated students in the field of Chemistry/Materials Science/Physics/Electrical Engineering willing to work in a multi-disciplinary team to carry out systematic experiments for material analysis.

Contact

If you are interested or want to learn more, please contact Dr C. Cancellieri (claudia.cancellieri@empa.ch).

[1] M. Chiodi et al., J. Mater. Chem. C 4, 4927 (2016).

[2] F. Moszner et al., Acta Materialia 107, 345-353 (2016).

[3] V. Araullo-Peters et al., ACS Appl.Mater. Interfaces 11, 6605-6614 (2019).