Thin-film ceramics for energy applications

P. Eklund[1]

IS

[1]Department of Chemistry - Ångström Laboratory; Inorganic Chemistry, Lägerhyddsvägen 1,751 21 Uppsala, Sweden
per.eklund@kemi.uu.se

This invited presentation gives an overview of our research on selected thin-film-ceramics for energy applications in the field of protective coatings and energy harvesting. Protective coatings made by energy-efficient reactive sputter deposition for applications in electrochemical cells and nuclear fuel rods are surveyed. Dense, hard coatings in the CrNbN system ranging from nitrides to supersaturated metal solid solutions offer wear resistant coatings that also have potential to withstand the harsh conditions nuclear fuel rods are exposed to in a reactor. In particular, Cr-rich coatings with 2-6 at. % and 10 at.% exhibit notably dense microstructures with relatively high hardness, properties of the essence for protective coatings. For thermoelectric devices, I present an overview of our work on multicomponent CrN-, ScN-, and $Ca_3Co_4O_9$-based thin films. We have developed methodology for highly textured as well as nanoporous virtually phase-pure $Ca_3Co_4O_9$ thin films. These can further be deposited on flexible mica substrates, enabling flexible inorganic thermoelectric thin films that withstand repeated bending. They can also be made as free-standing films and as nanoporous materials for reduced thermal conductivity. CrN exhibits n-type conduction with a high power-factor enabled by a high electron concentration thermally activated from N vacancies, and alloys can be made of rocksalt-$Cr_{1-x}Sc_xN$. Multicomponent alloying of ScN and CrN in alloys such as CrMoVWN or combinations thereof offer further possibilities for tailoring the thermoelectric properties and growth conditions.