

PO3093

Corrosion resistance of PVD protective coatings at high temperatures

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In concentrated solar power plants (CSP) the use of nitrate salt melts as media for energy storage greatly enhances energy storage capacity due to their potential to operate at temperatures as high as 570°C. The chemically aggressive ambient combined with the high temperatures implies severe requirements on the physical and chemical inertness of materials in contact. Similar conditions hold during precision molding of micro-optical components where hot glass melts are in contact with the surface of molding tools. In both cases, dense and mechanically stable coatings with high resistance against oxidation and diffusion of ionic species even at high temperatures are required to protect substrate materials of lower mechanical, thermal and chemical stability.

We developed binary and ternary nitride coating materials, in part alloyed with noble metals, and investigated their behavior under exposure to molten nitrate salts and molten glasses in temperature regimes above 500°C. The coatings were prepared by RF- and MF-magnetron-sputtering and deposited on stainless steel and silicon substrates. Corrosion experiments were performed under static and dynamic conditions. In static mode the samples were exposed to the corrosive media under constant high temperature conditions. The dynamic testing included a thermal cycling where the coating materials under investigation underwent fast changes in temperature and surrounding ambient.

The impact of corrosion on the properties of the coatings and underlying substrate was analyzed by optical microscopy, scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDX) on sample surfaces and cross-sections. In addition hardness and reduced modulus were measured by nanoindentation. In this way, we identified promising coating materials with good oxidation resistance and thermomechanical stability even in aggressive ambient conditions such as those found in CSPs or glass molding processes.

Keywords

PVD coating

corrosion

molten nitrate salt

glass melt