OR1308

Corrosion behavior, hardness and electrical resistivity of nitrogen-doped hydrogenated carbon coatings

Martin Fenker[1], Kerstin Petrikowski[1], Thorsten Forster[2], Burghard Lutter[2]

[1]fem, Schwäbisch Gmünd, Germany [2]ZBT, Duisburg, Germany

fenker@fem-online.de

Metallic bipolar plates in polymer electrolyte membrane fuel cells (PEMFC) have to be electrically conductive and corrosion resistant. However, when using stainless steel as bipolar plates it degrades during cycling tests. One solution is the deposition of conductive corrosion resistant coatings like e.g. carbon-based coatings. For this reason, amorphous N-doped hydrogenated carbon (a-C:H:N) coatings have been deposited onto stainless steel foils by plasma-activated chemical vapor deposition (PACVD) by using a plasma beam source (PBS). Molecular nitrogen is added to acetylene (C_2H_2) to prepare N-doped coatings. The properties of the a-C:H coatings are changed by varying the total pressure, the N_2 partial pressure $p(N_2)$ and the substrate temperature (100-300 °C). For the investigations, a-C:H:N coatings have been deposited onto glass, silicon and stainless steel (1.4404) substrates.
The hardness of the coatings was measured by instrumented indentation tests. The electrical resistivity was acquired by 4-point probe and contact resistance measurements. The corrosion behavior was studied by a three electrode configuration in sulphuric acid at 80 °C. The hardness was found to decrease with increasing total pressure and with increasing $p(N_2)$. The reason for the reduced hardness with increasing total pressure is the decrease in ion energy. It is assumed that the generation of sp^3 bonded carbon is reduced (less kinetic energy for subplantation) and the number of sp^2 bonded carbon is increased. However, the increase in sp^2 bonded carbon enhances the electrical conductivity. The substrate temperature has no significant influence on the hardness values. Electrically conductive coatings have been obtained by N-doping the a-C:H coatings. The corrosion behavior will be discussed with respect to the microstructure, defects and adhesion of the coatings.

Keywords
PEMFC
PACVD
carbon coating
electrical resistance
corrosion