Determination of hard alumina-film material characteristics by means of nano-indentation measurements

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Four types of Al_2O_3 films were anodically formed on aluminium AD-3 in working electrolyte contained 180 g/l H_2SO_4. The electroformation of the two types of alumina films was realized at two different temperature of the electrolyte - at 0ºC (for "hard" anodization) and at 25ºC (for "normal" anodization). Part of the samples obtained in both temperatures was further treated in boiling water for one hour in order to seal the film pores.

The two mechanical characteristics of the films, the indentation (H_{IT}) and the indentation modulus (E_{IT}), were determined via nanoindentation tests. All measurements were done with G200 nanoindenter (Agilent Technologies) by diamond Berkovich tip. Time dependent effects were investigated by tests with different peak hold time and different loading rate. The change of the mechanical properties with indentation depth is also examined. The effect of the working temperature during the growth of the alumina layers and the influence of the pore sealing on the mechanical properties are evaluated via comparison of the average load-displacement curves. The role of the electrical regime (formation voltage and current density), the temperature of the electrolyte and sealing process) during the formation of the alumina films, with respect to possible changes of their chemical composition and structure, are discussed in order to explain the observed differences in the measured oad-displacement curves and the determined H_{IT} and E_{IT}.

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