Vanadium Nitride Thin Films And Nanoclusters: Growth And Electrochemical/XPS

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Abstract

Pseudocapacitive or electrochemically active materials can achieve capacitance values up to 10 times greater than those obtained by materials based only on an electric double layer (EDL) mechanism. The pseudocapacitive behavior of transition metal oxides has been extensively studied in the last decades and assigned to redox reactions occurring at the surface of the material. Very recently, transition metal nitrides such as Mo_xN, VN or TiN have emerged as promising electrode materials for electrochemical capacitors. These materials are inexpensive, have a high molar density good chemical resistance and, most importantly, in contrast to oxides they exhibit very high electronic conductivity value. Extremely high specific capacitance values of 1340 F g^{-1} was reported for nanostructured VN [1]. To shed some light on the mechanism of such huge capacitance we have carried out a comparative study of VN thin films and VN nanoclusters grown and characterized *in-situ* to relate electrochemical properties with the structure and composition of the surface of vanadium nitride.

An UHV system (SPECS) equipped with tools for XPS, e-beam assisted evaporation of metals, high pressure cell and electrochemical cell for I-V cycling was used for in-situ synthesis and characterization.

A recipe to grow VN thin films and nanoclusters via direct nitridation of thin vanadium film in atmosphere of 1 bar N_2 at temperature 800 ^oC has been developed. Stoichiometry of the VN_xO_y compounds can be controlled by post oxidation of VN in oxygen atmosphere at elevated temperature. Growth of VN nanoclusters using the same procedure has been performed on HOPG surface.

Electrochemical characterization of VN thin films demonstrated impressive areal capacitance of ~2000 µFcm^{-2} in 1M KOH electrolyte at scan rate 1Vs^{-1}. XPS characterization was applied to elucidate electrochemical reactions occurring on the surface of VN films.

References

[1] D. Choi et al., Adv. Mater., **18** (2006) 1178