10.9 Technologies and Apparatus for thin Layer Coatings of Accelerator rf Subunits

by J.Lorkiewicz[1),3)], B.Dwersteg[2)], A.Brinkmann[2)]

Multipactoring in high power rf components takes place whenever certain resonance conditions for electron trajectories are fulfilled and the impacted surface has a secondary electron emission coefficient bigger than one. Multipacting currents absorb rf power and deposit it as heat in localized areas. They often cause breakdowns in couplers, higher order mode absorbers, rf windows etc. A number of means has been proposed to avoid the above effects. Apart from avoiding geometric resonant conditions in couplers, transmission lines or resonant cavities one can use thin layer surface coating to reduce the secondary electron emission. Of the commonly used coating materials (chromium oxides, titanium or titanium compounds) titanium nitride shows sufficiently low secondary electron emission and good stability in the rf field. To cope with multipactoring problems a number of components of rf couplers for TESLA facility at DESY has been TiN coated [1,2]:

- DESY-TTF-II coupler coaxial line metallic components
- DESY-TTF-III coupler cylindrical 300 K ("warm") ceramic windows (20 pieces)
- DESY-TTF-III coupler cylindrical 70 K ("cold") ceramic windows (21 pieces)
- flat waveguide ceramic windows for the main TTF coupler (21 pieces).

Before the TiN coating the performance of the flat waveguide windows of the main TESLA coupler showed problems with power transmission associated with intense secondary electron and light emission. The window of this type consists of an alumina disc installed in a stainless pillbox-type container. It fulfills the resonant condition for two side multipacting in an electric field.

TiN layers on ceramic or metallic surfaces has been created by deposition from titanium vapour in ammonia. The vapour was sublimated from electrically heated Ti wire. The effect of coating procedure on multipactoring suppression was first studied using a multipactor test resonator at DESY [3]. The device enables a straightforward measurement of rf multipactoring current between two electrodes of a specially designed coaxial resonator. Twelve pairs of electrodes of aluminum or copper were TiN coated using different processing conditions and next tested. Time needed to overcome multipactoring (suppress the current) was used for selection of processing parameters. The best results were reached for single coating operations at titanium deposition rates on a substrate between 6 and 15 nm/min. at a pressure of ammonia of 10-3 mbar. For better Ti - TiN chemical conversion the substrate with the deposited Ti layer was kept for 1-3 days at a pressure of ammonia increased to several hundred mbar. The chemical composition of a layer has been further checked using SIMS method [4]. TiN content reached typically more than 80% and there were some small titanium oxide admixtures.

TiN coating of the above rf power components was performed in a vacuum vessel evacuated by a turbopump. The sublimation setup for each sort of components consisted of vertical, 1 mm diam. titanium wires or wire loops (catenaries), appropriate platforms and shields . Due to a complicated geometry the setup for coating the flat waveguide windows was designed after numerical simulation of the layer thickness distribution. The surface processing improved significantly the rf operation of the waveguide windows:

- full power transmission has been reached
- no secondary or light emission was detected and
- rf performance was insensitive to a previous 1 day exposition to the atmosphere.

In addition two pairs of 300 K and 70 K coated ceramic cylindrical windows have been installed in couplers.

[1] J.Lorkiewicz, B.Dwersteg, Current activities in TiN coating at DESY, TESLA Input Coupler Workshop, LAL Orsay, January 17-18, 2000.

[2] J. Lorkiewicz, B. Dwersteg, Example for coating by sublimation: TiN for RF windows, Workshop on Thin Film Coating Methods for Superconducting Accelerating Cavities, DESY, July 10, 2000,

[3] D.Proch, D.Einfeld, R. Onken, N. Steinhauser, Measurement of Multipacting Currents of metal Surfaces in RF Fields, unpublished.

[4] P. Willich, Analysenbericht, Fraunhofer Institut Schicht- und Oberflaechentechnik, Bienroder Weg 54E, D-38108 Braunschweig, 20 Nov. 1999 - report on SIMS analysis of TiN layers on ceramic and copper substrates (in German).

1) IPJ, Otwock-Świerk, Poland
2) Deutsches Elektronen Synchrotron (DESY), Hamburg, Germany
3) Now at DESY, Hamburg, Germany