



COATING INSIDE TUBES

INTRODUCTION

The Tribology Centre at Danish Technological Institute has set up a PVD coating facility capable of coating thin films on the inside of both conducting and nonconducting tubes. The thin film is deposited by magnetron sputtering by moving a sputtering cathode and anode inside the tube.

The coating facility can handle tubes with a length up to one meter and dimensions down to 22 x 40 mm². Titanium coatings are readily available, but other metals can be deposited on request.

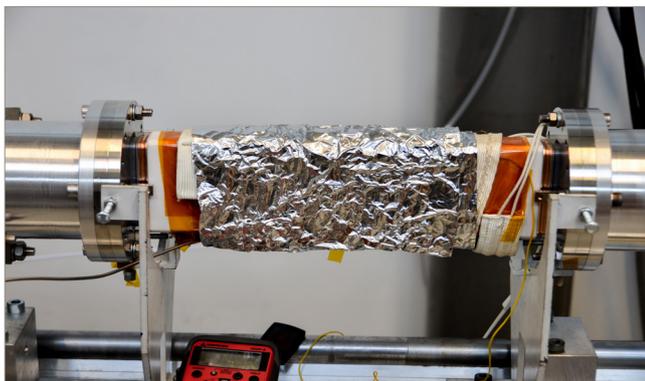


Figure 1:
40 cm long Al₂O₃ ceramic tube during inside coating by titanium at 150 °C. The ceramic tube is wrapped in aluminium foil to obtain a homogenous surface temperature.

Thin film deposition inside tubes for high-end applications

APPLICATIONS

So far, ceramic Al₂O₃ tubes for storage ring/accelerator facilities have been coated with titanium on the inner wall to achieve a target specification of the flange-to-flange electrical resistance of 5.3 Ω at a deposition temperature of 150 °C. Figure 1 shows the Al₂O₃-tube mounted in the tube-coater whereas Figure 2 shows the tube after the titanium layer has been deposited.

The present tube is for an injection kicker magnet for the Synchrotron-Light source for Experimental Science and Applications (SESAME) in Jordan.



Figure 2:
Ceramic Al₂O₃ tube after coating the inside with titanium. The tube has been coated by titanium until the flange-to-flange electrical resistance has reached 5.3 Ω at 150 °C. The tube is for an injection kicker magnet for the SESAME synchrotron.



COATING INSIDE TUBES - PROPERTIES

Thin film coating	
Inner tube dimensions (L x W x H)	<1000 mm x (20-200 mm) x (44-200 mm)
Deposition temperature	Ambient temperature to 180 °C
Base pressure	$\sim 10^{-7}$ mbar or $\sim 10^{-5}$ Pa
Flange to flange resistance	$\sim 2 \Omega$ to 100Ω , depending on geometry

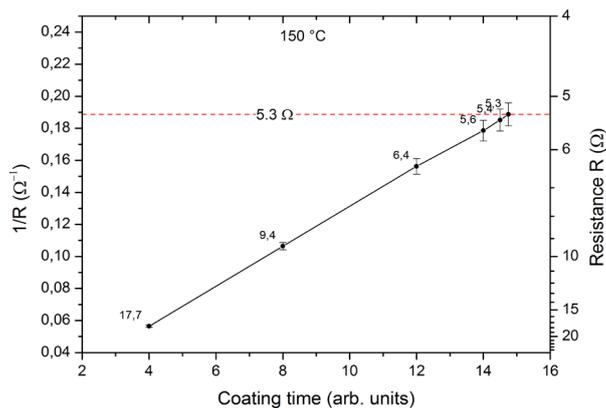
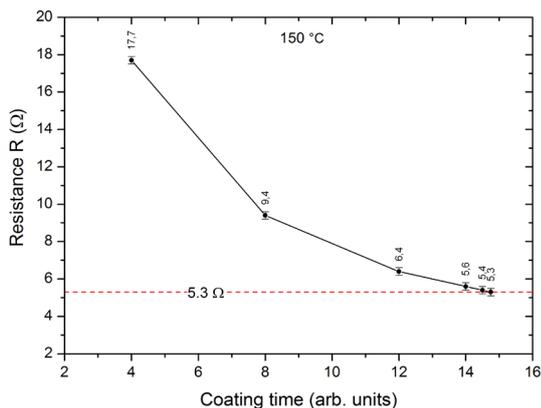


Figure 3:

The actual titanium thickness meeting the specifications of a tube flange-to-flange resistance of 5.3Ω depends critically on the actual surface roughness of the tube. Thus, the titanium thickness is gradually increased by moving the sputtering source back and forth during deposition until meeting the specifications.