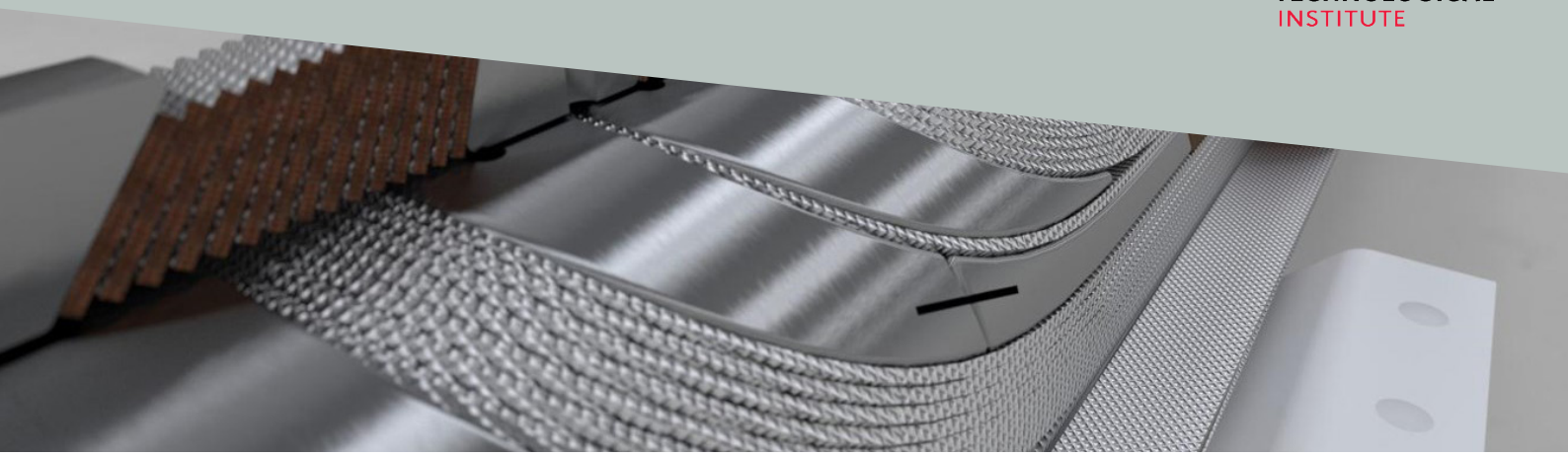
DANISH TECHNOLOGICAL INSTITUTE



NEWSLETTER DTI TRIBOLOGY CENTRE

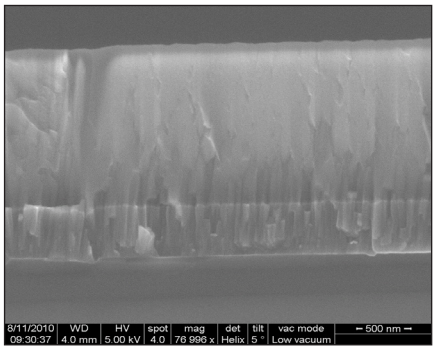
June 2018

50 µm thick PVD Al_2O_3 for next generation superconducting magnets at CERN

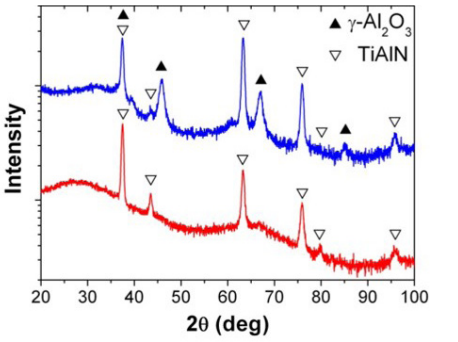
At CERN, the next generation of superconducting magnets is under development. In the prototype, which is currently being assembled, a PVD Al_2O_3 coating, developed and produced by the Tribology Centre at Danish Technological Institute, plays an important role. The superconducting magnet consists of bundles of superconducting Nb_3Sn wires, which are separated by metal spacers with electrically insulating surfaces. The electrical insulation of the surface is obtained via a 50 µm thick PVD Al_2O_3 coating. In addition to being electrically insulating, the Al_2O_3 coating is capable of withstanding several thermal stress cycles involving cooling to operating conditions at -270 °C and heating to 650 °C without delamination.

The Al_2O_3 coating delivered to CERN is an extremely thick version of the so-called low-temperature Al_2O_3 coating provided by the Tribology Centre. The low-temperature Al_2O_3 coating is produced at a deposition temperature of 250 °C, which makes it applicable to a wide range of substrates. It has an XRD-amorphous structure and a hardness of 9 GPa, which is sufficient for most applications. However, for applications involving severe stresses, the Tribology Centre recommends a high-temperature Al_2O_3 coating, which is deposited at 550 °C. The high deposition temperature gives rise to a hardness of 19 GPa due to the formation of γ-Al_2O_3 crystallites. Both the low- and high-temperature Al_2O_3 coatings are deposited with a TiAlN adhesion layer, as seen in the cross-sectional SEM image, below.

In general, Al_2O_3 coatings are well suited as electrical insulators – especially in applications where electric insulation is needed in mechanical contacts. In addition, different industrial segments apply Al_2O_3 coatings as an inert non-stick coating to avoid seizure of spacers and holders during welding, sintering, etc.



Cross-sectional SEM image of the Al_2O_3/TiAlN coating.



XRD pattern of the coating. Low temperature version (red) and high temperature version (blue) revealing the presence of γ-Al_2O_3.

	Low-temperature Al_2O_3	High-temperature Al_2O_3
Deposition temperature	250 °C	550 °C
Hardness	9 GPa	19 GPa
Thickness	Typically 1-5 µm	Typically 1-5 µm
Microstructure	amorphous	γ-Al_2O_3
Chemically inert	Not in alkalides	Yes

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