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ELECTRON MICROSCOPY ANALYSIS OF NANOCRYSTALLINE DIAMOND LAYERS ON ZIRLO

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There is a need for additional energy generation capacity in South Africa, and the government has identified nuclear power as part of the future energy mix. For safety, economics and reliability of nuclear energy generation the issues that affects the cladding material (i.e. ZIRLO) such as waterside corrosion, which limits the life time of the fuel tubes, must be resolved. Zirconium alloy is the main physical barrier between the coolant system and the nuclear fuel(1). Its principal role is to keep the radioactive products produced during the fission process contained in the fuel pin1. One solution is to find a way to protect the ZIRLO with a protective coating against oxidation. When oxidation takes place in the waterside of the zirconium alloy, hydrogen is released to the coolant and the cladding material absorb some of it which leads to formation of zirconium hydrides that are brittle in nature(2).

Since this problem is surface related the ideal coating must improve the reaction kinetics of the fuel tubes with steam. The aim is to suppress hydrogen generation, since this is related to hydrogen gas explosions under accident conditions. Diamond is known for its outstanding properties, such as high thermal conductivity, low chemical reactivity, extreme hardness, wear resistance and it can withstand high temperatures (3, 4). Due to these properties it has been considered as a material of choice for a large variety of applications (5) especially as a coating material. Since it also has low neutron capture, diamond is a material with applications in the nuclear industry.

This paper reports on the characterization of a nano crystalline diamond (NCD) layer grown on a ZIRLO surface by microwave plasma-enhanced linear antenna chemical vapor deposition (MW-LA-PECVD) apparatus. The samples were grown at the MW-LA-PECVD reactor at the Institute of Physics, Czech Republic using gas mixture of Hydrocarbons-Hydrogen.

The NCD coated samples were sectioned using a diamond wire saw and mounted using carbon stub. The samples were then carbon coated and investigated by scanning electron microscopy (SEM) using secondary electron (SE) imaging. Electron Energy-Loss Spectroscopy (EELS) was used to confirm whether the coating is diamond or a carbon like structure. A Helios NanoLab FIB SEM was used to cut transmission electron microscopy (TEM) lamellae from specific areas of interest. The TEM lamellae were investigated in a JEOL 2100 LAB6 TEM operated at 200 kV.

References
1) Kim, H.H. et al. (2010) J. Mater. Sci. Technol. 26(9) 827-832.
2) Motta, A.T., Chen, L.Q. (2012) J. Min. Met. Mater. Soc. 64 (12).
3) Kratochvilova, I. et al. (2011) J. Mater. Chem. 21 (18248).
4) Balmer, R.S., et al. (2009) J. Phys.: Condens. Matter 21 (364221).
5) Ashcheulov, P. et al. (2015) Appl. Surf. Sci 359 621-628.

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No

Level for award
 (Hons, MSc,
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