Seminar

==========

Institute for Plasma Research

==========

Title: Plasma oxidation of FeCrAl alloys

Speaker: Mr. Rudrang B. Chauhan
M. S. University of Baroda, Vadodara

Date: 06th July 2023 (Thursday)

Time: 11:00 AM

Venue: FCIPT Seminar Hall & Hybrid mode

Online Link:
https://meet.ipr.res.in/join/2104342544?be_auth=NDg4NzIx
(Conference ID: 2104342544; Password: 488721)

Abstract

The FeCrAl alloys have ability to form alumina scale when exposed to high temperature conditions. The high temperature stability of such alloys strongly depends on the structure and integrity of the resultant oxide so formed. Factors such as chemical potential and electric field has a profound effect on such oxides. Use of plasma oxidation to form such plasma grown oxide is of interest to explore improved oxidation resistance of FeCrAl alloys. The plasma grown oxide scales have been reported to be beneficial with better dielectric properties compared to thermally grown oxides. This study thus aims at a comparative evaluation of the thermally grown alumina scales on FeCrAl alloys against the plasma grown oxides. The effect of polarity (unipolar pulse and bipolar pulse) during pulsed plasma oxidation on the resultant oxide was also studied. The characterization of grown oxides was done with the help of XRD, Raman spectroscopy and SEM/EDS. The microhardness measurements were also done for checking the change in bulk properties after oxidation treatments. The effect of changing the pulsing polarity (unipolar/bipolar) was also noted.

Samples were subjected to several temperature and time intervals. Phase analysis from XRD, SEM/EDS and Raman spectroscopy confirmed the presence of α- Al2O3. Unipolar plasma treatment yielded complete transformation to α- Al2O3 phase with absence of any meta stable alumina phases. The W-H plot analysis of XRD data from such samples revealed 40 nm crystallite size unipolar plasma treated samples, while bipolar plasma grown oxides showed 60 nm crystallite size. In contrast to this, the thermally grown oxide scales revealed 116 nm crystallite size in alumina. It has been reported recently that smaller crystallite sizes (<100 nm) result in enhanced oxidation resistance. Such small crystallite size could be possibly due to the vacancy induced defect structures which may have facilitated nanocrystallite formation. However, a detailed study may be needed to investigate the root cause. The phase anaylsis using XRD and surface morphology confirmed presence of mix of α and γ- Al2O3 in bipolar pulsed plasma treated samples, while the thermally treated samples revealed only metastable γ- Al2O3. The effect of such treatments on the bulk properties were investigated using microhardness measurements. The Vickers microhardness values measured for the treated samples (~248 HV0.2) were close to the untreated samples (~249 HV0.2). Moreover, the calculated values of tensile strength and yield strength were near to that of untreated Kanthal-A1. The bulk properties after treatment remained unaltered.

Keywords: FeCrAl alloy, Plasma, oxidation, alumina