

TRIBOLOGICAL BEHAVIOUR OF FE-10CR-4AL AT ELEVATED TEMPERATURES UNDER DIFFERENT ENVIRONMENTAL CONDITIONS

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Wear, friction, fretting, high temperature

ABSTRACT

Lead-cooled small modular nuclear reactors require enhanced understanding, prevention, and prediction of material degradation in liquid lead. Critical components include the fuel rods, heat exchanger, and pump impeller. These functional elements are exposed to temperatures of up to 550 C° combined with mechanical loads and flow-induced vibrations [1]. Under such conditions, fretting wear can occur between the spacer wire or supports and the outer surface of the fuel- or heat exchanger tubes. Fretting damage in liquid lead can lead to fretting corrosion after removal of protective surface oxide layer and exposure of the metal to liquid lead [2]. FeCrAl alloys are promising candidates for nuclear grade steels as a thin alumina oxide layer on the surface protects the metal from corrosion and lead penetration and provides self-healing properties in stagnant lead and low oxygen pressures [3]. However, the tribological performance of FeCrAl is not fully understood. The aim of this study is to characterize the friction and wear of Fe-10Cr-4Al under various environments including liquid lead.

The tests were conducted using a reciprocating tribometer in line contact configuration at room temperature and high

temperature (550 C°) under ambient atmosphere and in protective gas (95% Ar 5% H₂) and liquid lead environment. Detailed analysis of wear mechanisms and tribolayer composition was performed by SEM/EDS analysis. As shown in Fig. 1 the wear mechanisms are significantly affected by oxidation and presence of liquid lead. The highest coefficient of friction was obtained at room temperature in ambient environment tests, while the lowest level of friction was observed in the high temperature ambient environment tests. For both of these conditions, the COF was stable throughout the test time, while the high temperature tests in gas environment or in gas environment and liquid lead showed high COF and significant fluctuations of values due to destruction of the surface oxides and/or tribolayer.

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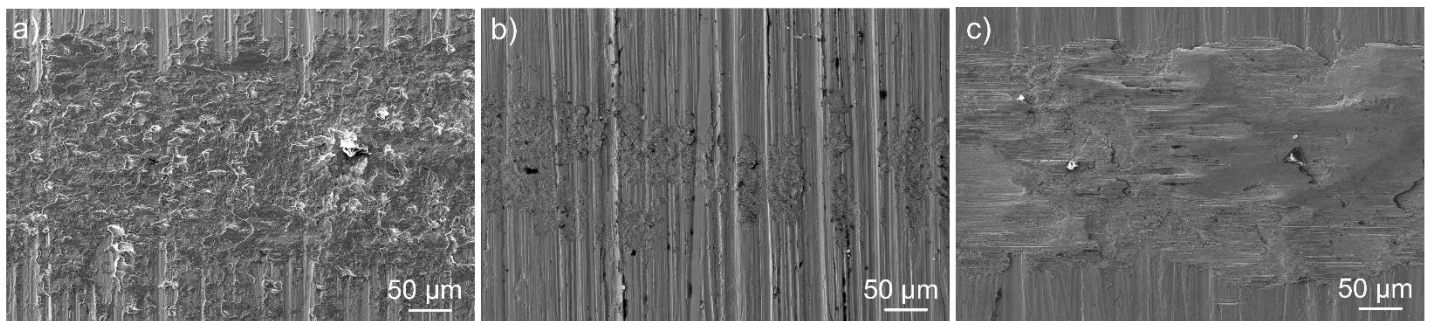


Fig.1 SEM micrographs of sample after testing at a) RT and ambient atmosphere, b) high temperature and Ar+5%H₂, and c) high temperature, Ar+5%H₂ and liquid lead.