Experimental report

04/01/2022

Proposal: 1-04-190 **Council:** 4/2020

Title: Strain measurement of ultra-thick tungsten coating for nuclear fusionapplications

Research area: Materials

This proposal is a new proposal

Main proposer: Wen CUI

Experimental team: Thilo PIRLING

Local contacts: Sandra CABEZA
Thilo PIRLING

Samples: free tungsten coating
free stainless steel sample
tungsten coating on steel substrate

Instrument	Requested days	Allocated days	From	To
SALSA	5	5	04/02/2021	09/02/2021

Abstract:

Tungsten is one of the most promising materials to be used as protective coating layer of the steel frame parts of the divertor component in a fusion reactor. However, fabrication of thick tungsten coating on steel is notoriously difficult due to the significant mismatch of thermal expansion coefficient between tungsten and steel. Large thermal strain developed at the interface of the two materials often causes catastrophic coating detachment. We have successfully manufactured millimetre thick tungsten coatings directly on steel, employing a new surface sculpture technique for strain management. The proposed experiment aims to measure and quantify the strain within the tungsten/steel coating system, in order to understand the influence of surface sculptures on strain, and to provide generic insight into stress relief in dissimilar material systems.

Experimental report

The experiments were performed remotely by beamtime scientists due to Covid restrictions. Samples were FAST-processed tungsten coatings on pre-patterned steel substrates. Neutron diffraction data were collected on four specimens, including two tungsten coated steel samples with coating thicknesses of approximately 2mm and 4mm respectively, and two pure tungsten samples of identical thicknesses (without steel substrates) for reference. Figure below shows the setup for the two tungsten coated steel samples. W_211 and Fe_211 peaks were used for strain measurement. The normal and the radial strain components of all samples were collected, the hoop component was only collected from a single point scan on the reference samples due to time limitation.

Collected data were initially treated via ILL recommended software – LAMP for peak fitting and data reduction. Peaks were fitted by Lorentz peak functions and could be subject to a more advanced peak function if needed. A significant data were collected at surface or tungsten/steel interface, hence access to MathCad is needed and psedo-strain corrections is necessary for these entry scans. We are now waiting for assistance from the beamline scientist before being able to conduct stress calculations. As expected, preliminary results suggest that we have received good strain relief in all samples, and the magnitude of residual stress is expected to be small, further data treatment is needed for more detailed results.