COLLOQUIA

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Plasma and ions interaction with tungsten surfaces: interests for nuclear fusion

Abstract

Using nuclear fusion's power is the goal of the ITER tokamak, an international fusion reactor under construction in Cadarache (France). In the tokamak, a magnetically confined plasma of hydrogen isotopes (deuterium and radioactive tritium) is heated to millions of kelvin, and power exhaust is realized on the divertor tiles made of tungsten (W). A detailed understanding of the interaction of W with fusion fuel (deuterium and tritium) is needed, especially because tritium is a scarce and radioactive element. The interaction of ions with W can induce modifications in the material, such as blisters and bubbles [1-3]. Such (near-) surface modifications can be responsible, for example, of an increased fuel inventory in the reactor walls [4] and affect the optical properties of tungsten due to both an increasing surface roughness and a change of electronic properties of implanted materials. A cursory knowledge of the evolution of the divertor's optical properties during plasma interaction represents a risk as it may lead to inaccurate thermography measurements of plasma-facing components during reactor operation [5,6]. The proper functioning of fusion reactor therefore seems to be linked to a better understanding of the fundamental mechanisms controlling the interaction of charged particles (HI and He ions) with tungsten.

In this contribution we present different experimental studies performed at the PIIM laboratory (Aix-Marseille University, CNRS, France) using an arsenal of plasma and surface science technics: ion mass and energy spectrometry analysis, temperature programmed desorption, LEED, Auger spectroscopy, X-ray and UV Photoelectron Spectroscopy, ellipsometry.

We will focus on two main studies:

1) The retention behavior of deuterium in single-crystal tungsten and on recrystallized polycrystalline W samples [7-9].

2) The evolution of ellipsometry signal in presence of trapped deuterium.

Eventually, we will discuss the potential interest of these experimental findings for fusion applications.

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