Seminar

Institute for Plasma Research

Title : Studies on the Energetic Particles in Tokamak Plasma-Wall Interactions

Speaker: Dr. P.N. Maya
Institute for Plasma Research, Gandhinagar

Date : 19th January 2021 (Tuesday)

Time : 03.30 PM

Venue : Online - Join the talk: https://meet.ipr.res.in/Maya_PDF_extension_talk

Abstract :

Fusion-plasma-wall interactions (fPWI) are significantly complex due to the concurrent interaction of the plasma along with highly energetic fusion products and externally injected impurities with the wall. The non-linear interactions of various species with the wall can alter the fundamental processes of erosion, re-deposition and consequently the impurity generation and transport in the tokamak. Apart from fusion power, one of the key parameters for a reactor is the P/R where P is the heating power and R is the major radius. This becomes particularly important in the case of a spherical tokamak based fusion device, where the heat and particle flux to the plasma-facing components are much higher than a large aspect ratio machine. Such considerations can limit the pulse length of the machine.

In this talk we will discuss the constraints on the first-wall arising from the heat and particle loads and how they depend on the basic parameters of ST. Such studies require the understanding of how the energetic particles interact with the wall.

The energetic deuterium ion interactions with tungsten were investigated using ion-irradiation experiments and modelling. It was shown that the microscopic anisotropy arising out of the defects can modify the long-range deuterium transport in materials that along with the adsorbed impurity in the metal can significantly alter the nature of H-isotope trapping in metals [1]. The experiments have also shown for the first-time the theoretical conjecture of the spontaneous release of vacancies during the grain boundary migration as a part of volume conservation [2].

As an interesting aside a modelling study was carried out to understand the species composition in the plasma (H+ :H2 + :H3 +) and it is seen that the composition is greatly influenced by the plasma conditions in the ion source which will alter the defect profile in the material.

In future, we plan to develop a computational tool to study the poloidal distribution of the alpha-particles in spherical tokamak reactors and its associated effects such as heat and particle load profiles on the wall including centerpost, erosion and re-deposition on the wall etc. The energetic helium interaction with tungsten has shown an interesting similarity with the defect produced by 14.1 MeV neutrons and 3.5 MeV helium ions. This makes energetic helium as an interesting proxy for simulating neutron irradiation in metals. The ongoing activities in this area will be presented.

[1] P.N. Maya et al., 2020 Nucl. Fusion in press https://doi.org/10.1088/1741-4326/abd09e
[2] P.N. Maya et al., Materials Letters 283, 128801 (2020)