Plasma materials for nuclear fusion

Development and characterization of plasma materials properties

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In the near future, nuclear fusion could provide a clean, safe and virtually unlimited source of energy to meet the world's energy needs. To achieve this, it is necessary to recreate the extreme temperature and pressure conditions required to fuse hydrogen isotopes (deuterium and tritium) in nuclear fusion reactors such as tokamaks, thereby releasing a considerable amount of energy.
In this context, plasma facing materials (PFMs) are crucial components in nuclear fusion reactors, acting as the interface between the hot, high-energy plasma (~keV) and the walls of the vacuum chamber. PFMs have to withstand extreme conditions, including high temperatures, intense particle fluxes and bombardment by energetic particles and radiation emitted by the plasma, for a total energy that can reach a few GW/m^2. For these reasons, PFMs need to possess a combination of properties such as high thermal conductivity, mechanical and erosion resistance, and low reactivity with plasma species.
Tungsten, for example, is widely used for its heat resistance and low erosion properties. However, problems relating to changes in mechanical properties, migration of fuel and fusion products in materials, and tritium retention are still major issues. This is why understanding the interaction of PFMs with plasma and high-energy particles (such as neutrons) is essential to optimize the performance of nuclear fusion reactors and guarantee the durability of PFMs.
During the mini colloquium we propose to address three topics:
1) Characterization of PFM properties (mechanical, optical, heat extraction) under extreme conditions (temperatures, high thermal loads, interaction with ions and neutrons).
2) Plasma-wall interaction and associated phenomena, including particle and heat transport in PFMs, material erosion and deposition.
3) Development of advanced PFMs and coatings to improve heat dissipation, reduce erosion and minimize the adverse effects of ion and neutron interaction with materials (erosion, trapping, etc.).

During this 4-hour mini-colloquium, three speakers will introduce each topic, which will then be developed in short oral presentations.