FUSION TECHNOLOGY DESCRIPTION

EUROfusion
TECHNOLOGY TRANSFER PROGRAMME

ERO Code

ERO is a 3D Monte Carlo code for simulating the migration of impurities in plasma. It takes into account the source of the particles, disassociation and ionization, how the particles are transported, and also the interactions with boundary conditions. The models are supported by an extensive database that is constantly updated and complemented from different sources.

Description of the technology

The three-dimensional Monte Carlo code ERO simulates the transport of impurities through the edge plasma of fusion devices. Impurities are generated through plasma-wall interaction effects (physical sputtering or chemical erosion) but can also be externally injected through gas inlets. Normally the impurities start as neutrals from the surface. Independent of the plasma parameters they are ionised or dissociated at a certain distance from the surface.

The following movement is then determined by the Lorentz force, friction with the background, thermal forces and diffusion.

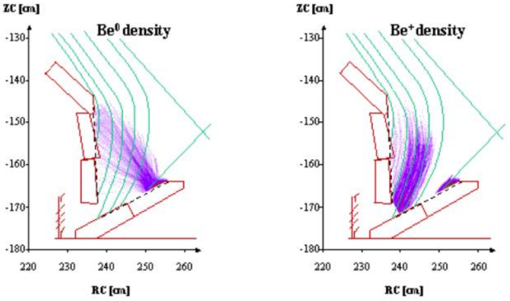
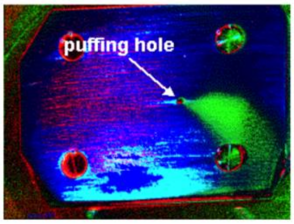
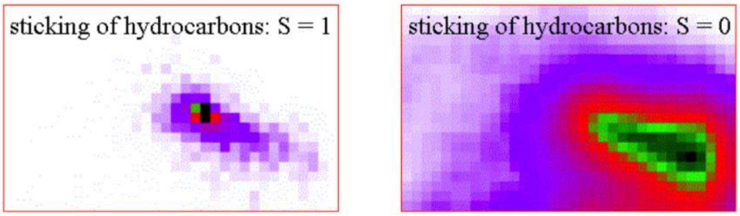


Figure 1: Transport of physically sputtered beryllium in the inner divertor of JET

ERO can be adapted to various experimental geometries (limiter machines like TEXTOR, divertor configurations like JET or ASDEX, as well as linear plasma simulators such as PISCES). The “standard” ERO version handles various geometries for test limiters such as roof or mushroom shaped tiles. In the simplest case the plasma background used for the simulations comes from measurements. In addition, edge plasma codes e.g. EDGE2D/EIRENE are routinely used to provide plasma conditions for ERO modeling and require Langmuir Probe and edge plasma profile measurements as boundary conditions.

Figure 2: (Top) Observed C-13 deposition pattern on a test limiter in TEXTOR after plasma exposure and CH4 C- injection through the puffing hole; (Bottom) modeled 13 patterns with carrying sticking assumptions for hydrocarbon radicals





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Axial Potential Separator suitable for Cryotechnics

The technology innovation is a new electrical potential separator for cryotechnics. It is applicable particularly to electrically isolating areas, in which different potentials occur. The device consists of a dielectric tube e.g. made of polyimide, which still isolates when subjected to low temperatures as a result of its material properties. An annular groove is located on the exterior of both end areas of the tube, in which a support ring is inlaid. Electrodes are applied to the tube such that they cannot be removed. The electrodes themselves are detachably connected to flanges that are pulled onto the face of the tube to seal the device. The technology is ready for use in the non--fusion domain and was patented by the inventors Stefan Fink and Günter Friesinger.

Innovation and advantages of the offer

ERO is highly adaptable and thus can be used for a range of applications

The model is detailed and accounts for many physical processes and inputs, including: plasma vessel geometry, particle sources (from chemical and physical erosion processes), molecule dissociation, atom ionisation, electromagnetic transport forces, plasma friction, cross--field diffusion, thermal sources, as well as solid surface interactions (i.e. reflection and sputtering).

An extensive database supports the physical models and is continuously updated (based on experimental results) from different sources, providing ever higher accuracy

Non-fusion Applications

At JET, the ERO code is currently applied to investigate:

- Carbon-13 marker injection experiments
- Migration of eroded wall material to remote area
- Erosion of poloidal limiters due to elm filaments
- Quantification of beryllium sputtering yields on poloidal limiters
- Migration of beryllium from an ITER--like Wall (ILW) main wall onto a tungsten divertor

The ERO code can be used to investigate processes that involve plasma-wall interactions, including:

- plasma gasification of waste
- electrostatic and electromagnetic space propulsion systems
- effects of space plasmas on spacecraft

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This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission