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# A Multi-Parameter Optimization technique considering temporal and spatial variation in nuclear response of materials in Fusion devices

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Structural materials present in and round any fusion device will face stringent conditions due to the high-energy, high-intensity neutron emitted from the fusion plasma. This will have significant life-limiting impacts on the reactor components of both experimental and commercial fusion devices. The neutrons interact with the material initiating nuclear reaction leading to the production of radioactive isotopes, gas molecules and related defects. These gases, particularly helium, can cause swelling and embrittlement of the material. Furthermore, the radioactive isotopes produce would cause heating in the material. These isotopes may have long lives which would contribute towards the radwaste produced in the fusion devices. Hence designing of low activation materials for fusion devices is warranted.

At Iter-India, Institute for Plasma Research a number of computational tools are being developed to estimate the nuclear response of the materials and to optimize accordingly. ACTYS-1-GO, a multipoint neutron activation code which can calculate radiological responses of materials located at various positions in a fusion reactor efficiently is developed. Also, a mathematical framework is developed for accessing the relationship of radiological quantity with the initial elements present in the material. Such framework helps in identifying and minimizing the fraction of most dangerous elements/isotopes from the material composition. In the present study both the methodologies are efficiently coupled for a complete material optimization. Quantities responsible for various radiological effects (like activity, dose, heat, and radwaste) and related defects in the material are considered and their contributing elements are optimized accordingly. Also, since a single material faces a gradient of neutron flux over its entire volume, all such optimization is carried out over the entire range of neutron flux faced by that material. This provides a comprehensive picture of the response of the material to neutron irradiation, enabling the assessment of structural integrity of components in a fusion device.

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