Modelling mechanical and radiation shielding properties of 316L-B_4C metal matrix composites

Karol Frydrych[1,2,*], **Maciej Maciak**[1], **Artur Olejarz**[1], **Wojciech Chmurzyński**[1], **Magdalena Gawęda**[1] **and Marcin Chmielewski**[3,1]

[1]National Centre for Nuclear Research (NCBJ), Otwock, Poland
e-mail: karol.frydrych@ncbj.gov.pl

[2]Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw, Poland

[3]Institute of Microelectronics and Photonics, Łukasiewicz Research Network, Warsaw, Poland

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Multi-functional materials are one of the key research areas driving technological progress. One example of a multi-functional material is the metal-matrix composite (MMC), where matrix phase consists of 316L stainless steel and reinforcement is made of B_4C. The material is still under development and it is hoped that it will possess excellent properties, such as excellent mechanical properties both at static and dynamic conditions, radiation shielding and resistance to corrosion.

During the presentation, two types of modelling results will be presented. First of all, finite element method simulations of mechanical response will be shown. To this aim, a two-phase material was modelled. The parameters of the (crystal) elasto-plastic model (cf. e. g. [1]) were calibrated by comparing model predictions to the experimental measurements. Similarly, the model of B_4C phase was established. Then, various computational microstructures of the MMC composite were generated in such a way to have the best representation of real microstructures observed under the microscope.

In addition, results of radiation shielding simulation will be presented. A series of simulations was performed for 316L steel samples containing various B_4C concentrations to determine the photon linear attenuation coefficients for standard ^{60}Co and ^{137}Cs gamma-ray sources, as well as the effective neutron attenuation coefficients for monoenergetic neutrons with energies ranging from thermal energies up to 20 MeV. In addition, the shielding performance was assessed in a realistic mixed neutron/gamma radiation field representative of the horizontal channel of the MARIA research reactor. The calculations were carried out using the MCNP and FLUKA Monte Carlo codes (cf. e. g. [2]) and the computational resources of the Świerk Computing Centre at the National Centre for Nuclear Research.

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