

## **Abstract for general public**

For nuclear application, radiation induced failure is one of the major limiting factors for the application of new materials as structural components in GenIV nuclear power reactors. On the other hand, high temperature industry, such as chemical or metallurgical, requires new materials able to maintain stable properties at high temperatures, under mechanical loading and poses sufficient resistance to harsh environment. It seems that all these requirements may be fulfilled by currently studied and developed novel materials. Establishing the connection between micro world and macro world is not only a philosophical issue, but also has strong scientific value. Hence, the primary goal of the proposed work is to develop novel materials and investigate the relationship between the changes at micro scale and the properties at macro scale in the novel materials. Via the project, it is expected to obtain an advanced material with both superior mechanical properties and enhanced irradiation resistance that can be used in the nuclear industry.

The experimental results obtained during the research will also be validated in collaboration with the numerical modelling teams at the host institution, NOMATEN Centre of Excellence (CoE). The CoE combines European Commission funding through Teaming for Excellence program and Polish funding by Foundation for Polish Science through International Research Agenda Programme – IRAP. The research will be conducted by a research team consisting of Dr. Wenyi Huo (principal investigator) and Dr. Lukasz Kurpaska (project mentor) at the CoE. The team will be supported by experience researchers in radiation damage via ion acceleration (to mimick neutron damage) prof. J. Jagielski, and experts in numerical simulations: prof. M. Alava (Nomaten CoE director) and Prof. S. Papanikolaou (Research Group Leader at Nomaten CoE).

Some attempts have been carried out, e.g., sample preparing and testing. It shows that micro-scale defects can give the novel materials outstanding performance. Next step, more samples with different micro characteristics will be designed and prepared, and they will be tested under irradiation conditions similar to nuclear reactor conditions to investigate their functional properties. The irradiated samples will be further examined as a part of the current project using the state-of-art facilities at the CoE. Goal of this investigation will be to understand the mechanical properties and irradiation resistance of novel materials with different micro characteristics. The PI will primarily conduct the experiments with the help of corresponding specialists at the CoE. The experimental results will provide the basis for preliminary qualification of the material. Recently, a few studies conducted on similar novel materials showed superior properties for the materials following irradiation. Therefore, the results in the current research are also expected to fall into a similar category and, at the same time, provide a more elaborative understanding of this new and unique family of materials.

The successful completion of the proposed project will move the research of innovative material alloys by leaps and bounds and revolutionize the current perspectives on the topic. The research topic is challenging and requires highly collaborative work between skilled scientists who possess various materials engineering competencies for nuclear applications. The expertise of the research team and other members at the CoE will be apt to handle such a project. In addition, the scope of the project fits the goals “Structure and Function” group at the CoE. The project will also augment the professional growth of aspiring young scientists such as the PI. It is expected, that implementation of this project will end with several, high impact scientific publications. This will significantly improve PI record and help in funding permanent position in research institution in Europe or USA. Furthermore, the development of a new type of material alloy in the current project represents solely a preliminary investigation, which shall be followed by further collaboration and validation, with much bigger consortia. The additional activities will be performed at the end of the project or shortly after completion.