# FUTURE OF NUCLEAR ENERGY AND NEEDS FOR ACCIDENT TOLERANT FUELS

**Professor Jerzy A. Szpunar, D.Sci, Ph.D., E. Eng.**
**Birks Chair in Metallurgy, Canada Research Chair Tier I**
**Professor of Materials Science**
**Department of Mechanical Engineering, University of Saskatchewan**
**jerzy.szpunar@usask.ca**

Development and use of accident tolerant fuel (ATF) in commercial light water reactors (LWRs), Generation IV nuclear reactors and small modular reactors (SMR) are studied extensively at present. This presentation will address research of our team in area of new high thermal conductivity composites based on urania, thoria and silicates and uranium and thorium. Presented work is both experimental and theoretical. We manufactured various types of composites with uranium and thorium, uranium carbides, silicates and borate and often obtained very significant improvement of thermal conductivity. We also performed for the first time detailed microstructural analysis and comparative studies of influence of porosity and fission products on the thermal conductivity.

Our computational prediction are based on Density Functional Theory (DFT) and were focused on prediction of thermal conductivity, electronic properties and structural changes of materials for fuels at very high temperatures, and under irradiation and also in oxidation environment. DFT and molecular dynamics (MD) is used to predict the thermal conductivity and mechanical properties in fuels with defects and with xenon (Xe) and zirconium (Zr) fission products. GenIV and SMR reactors will require special materials that have to serve in a very critical environment and should improve the safety and reliability of future reactors.

**Short Biography**

J.A. Szpunar, a professor of Materials Science at University of Saskatchewan, was educated in Poland and received his PhD and D.Sci degrees from the Academy of Mining and Metallurgy in Cracow. He has held various visiting positions in at Sussex and Durham Universities in England, worked in laboratories of the Finish Academy of Science, Riso National Laboratories and held visiting professor positions in Seoul National University, Queens University, Tohoku University, Osaka University and Bangalore Institute of Science and Technology. He also served as an adviser to the National Atomic Agency Research Center in Bandung, Indonesia and International Atomic Energy Agency in Vienna. His research interest spans various areas of materials related investigations. In particular he is interested in deformation and recrystallization processes in metals, structure and properties of thin films, electronic interconnects, high temperature oxidation and corrosion, synergy of wear and corrosion, application of X-ray and neutron diffraction, structure of grain boundaries and other interfaces, intergranular fracture, hydrogen generation and storage, hydrogen membranes, superplasticity and special properties of nanocrystalline materials His group is also active in the area of computer simulation of texture development during the deformation and annealing processes and electrodeposition. The simulation based research is done on various levels: atomistic, microscopic and macroscopic

Professor J.A. Szpunar is the author and co-author of over 800 research papers in international journals.