PURDUE UNIVERSITY | School of Nuclear Engineering

Nuclear Engineering Seminar

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3:30 pm | GRIS 103

Why the Sun and Stars work: The Case for Using Liquid Lithium for Fusion Reactor Operations

Abstract

Why does the Sun work? As always, the universe has beaten humans to the punch when it comes to doing something first. We all know that the Sun and stars are huge furnaces that compress hydrogen through gravity and fuse these atoms together to eventually make helium. That is the how, but the why is a more nuanced answer, one that I feel tells us exactly how we need to run our fusion reactors on earth if we ever want to achieve terrestrial fusion. To truly achieve a steady state working fusion power plant there is one major hurdle that needs to be overcome, plasma material interactions (PMI). The materials used to build these devices are extremely important. Traditional solid materials (tungsten, molybdenum, carbon, etc.) encounter many issues when exposed to the high heat fluxes in a fusion reactor's divertor region which can reach over 40 MWm^{-2} or more in some cases. Interactions with energetic ions, neutrals and neutrons can cause surface morphology changes (DPA, transmutation, fuzz, bubbles, blisters), ejection of material into the plasma, recycling of cold neutral gas back into the plasma and fuel depletion through implantation into the material. Liquid metals, and in particular liquid lithium (Li), offer several solutions to many of the issues solid materials face. As a liquid it is self-healing and can possibly handle the large heat fluxes seen in the divertor. Lithium's chemical reactivity means that it can trap impurities, unused fuel ions and neutrals that come out of the plasma. Li reduces the recycling rate of the wall and thus can increase the performance of plasmas. More importantly, recent results indicate that Li can also be a way to remove helium (He) ash effectively from a reactor. There are still technological challenges using liquid Li, and these are all under investigation. This talk will focus on PMI challenges and how Li can solve many of these issues. Why does the Sun work? … the answer to come!

Dr. Andruczyk is a Research Associate Professor in the Department of Nuclear, Plasma and Radiological Engineering at the University of Illinois Urbana-Champaign. He did his undergraduate degree in physics at The University of Queensland and completed his PhD at The University of Sydney where he gained extensive expertise in plasma diagnostics including the development and running of a diagnostic helium beam which was installed on the H-1NF Heliac in Canberra, Australia. He did his post-doc at the Max Planck Institute for Plasma Physics, Greifswald where the W-7X Stellarator is located and worked on the WEGA Stellarator. He came to UIUC on a post-doc but quickly rose to be a research scientist and was stationed at Princeton Plasma Physics Labs. He became a Research Assistant Professor at the Center for Plasma-Material Interactions when WEGA moved to the USA(now HIDRA). Prof. Andruczyk conducts research into plasma edge studies in particular the impact that PFC materials have on the performance of plasmas. He specializes in liquid metals, especially lithium, as potential future materials for plasma facing components in fusion devices. Daniel has run extensive experiments in reactors on flowing liquid lithium systems and this has led to him (and UIUC) being one of the lead PI's and lead institutions in the DOE's domestic liquid metal PFC development program along with PPPL and ORNL. He is also the director of the NPRE departments professional Master of Engineering in Plasma Engineering program.