
Powder Manufacturing Infrastructure to Support Advanced Nuclear Manufacturing and Materials

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ABSTRACT:

Through this university infrastructure development project, Purdue University will expand its Nuclear Science User Facilities (NSUF) capabilities by acquiring an ultrasonic powder atomizer for advanced nuclear manufacturing and materials research. Powder-based advanced manufacturing technologies, including powder metallurgy-hot isostatic pressing (PM-HIP), laser powder bed fusion (LPBF) additive manufacturing (AM), laser direct energy deposition (LDED), electron beam melting (EBM), cold spray technology, have gained prominence in the nuclear industry to manufacture future nuclear components and apply claddings. These methods are being extensively studied to fabricate nuclear structural components, nuclear fuels, nuclear waste storage and disposal, and sensors, covering a wide range of dimensional and precision requirements for net-shape structure manufacturing.

The spherical powder is critical to all the aforementioned technologies. However, powder fabrication facility is not available in NSUF infrastructure and significantly limits the development of advanced nuclear materials and manufacturing. Due to the limited powder resources and long lead time of customized powder production from commercial powder producers, most current R&D efforts are limited to the powders that are commercially available in the market. It could take 6-9 months and a much higher cost to get a customized powder from a vendor. In many cases, powder producers are reluctant to take powder orders for small quantity purchases, which is often the case for R&D. An in-house powder fabrication capability can significantly reduce the dependence of university researchers on commercial powder vendors and accelerate material and manufacturing innovations.

Beyond research benefits, powder fabrication capability can also be integrated into the existing education and training practice. Manufacturing education at different levels, from community college to graduate school, is critical to developing the nuclear manufacturing workforce and supporting small-modular reactors (SMRs) deployment. The equipment will be utilized to develop new courses, teaching materials, lab practice, and support outreach activities to fulfill our education mission.