Development of a Lead-Bismuth Cooled Subcritical Fast/Thermal Testbed for Material Radiation Damage Studies

M. Mamtimin[1], T.L. Grimm[1], R.N. Wahlen[1], F.Y. Odeh[1], W.A. Peters[1],
S.A. Maloy[2], K.A. Woloshun[2]
W. Yang[3], P.Deng[3]

[1]*Niowave, Inc., 1012 N Walnut St, Lansing, MI 48906*
[2]*Los Alamos National Laboratory, P.O. Box 1663, Los Alamos, NM 87545*
[3]*Department of Nuclear Engineering & Sciences, University of Michigan, 2355 Bonisteel Blvd, Ann Arbor, MI 48109*

Research and development of Generation IV fast reactors relies on novel materials that are resistant to both radiation damage and corrosive environments. The lack of data for most of these novel and advanced materials calls for renewed testing efforts performed in a prototype fast reactor environment of intense fast neutron flux. However, since the shutdown of the Fast Flux Test Facility, there are no operating fast reactors domestically. Recently, the Department of Energy (DOE) established the missions and requirements for a new U.S. test reactor that can cover all the potential needs of users. Correspondingly, the Idaho National Laboratory (INL), with the DOE, has initiated a Versatile Test Reactor program to facilitate the development and maturation of such a concept. Meanwhile, private industries like Niowave are also interested in designing alternative low-cost expedited facilities to provide fast spectrum neutron irradiation capabilities.

Niowave is developing a hybrid fast/thermal spectrum subcritical testbed (HYST) that can provide a high fast neutron flux, without the logistical and regulatory challenges of reactors. HYST is comprised of a hybrid fast/thermal core configuration, coupled to an electron linac-based neutron source that provides a fast reactor-like environment with 10^{15} n/cm^{2}s fast flux level, sufficient to provide the essential high material-damage rate of 20 dpa/yr. The fast region has a volume >100 cm^3 for testing advanced nuclear reactor materials (i.e., fuel, cladding, structure, etc.). This facility will be used to characterize and examine novel fuels and materials, test instruments and components, evaluate reactor safety designs, provide data for reactor code development, and support the regulatory process for licensing the novel technology. A scaled-down version of this system was designed, licensed, and constructed in-house with collaboration efforts from Los Alamos National Laboratory and University of Michigan. The system is currently operational at low-power performing reactor-physics experiments. A standalone electron linac-based neutron source with LBE converter (decoupled from any core) is capable of providing the same flux magnitude as indicated above, however, in a small 10 mm^3 volume suitable for small-scale tensile specimens.