

1. Curved Waveguide Based Nuclear Fission for Small, Lightweight Reactors

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The focus of the presented work is on the creation of a system of grazing incidence, supermirror waveguides for the capture and reuse of fission sourced neutrons. Within research reactors, neutron guides are a well known tool for directing neutrons from the confined and hazardous central core to a more accessible testing or measurement location. Typical neutron guides have rectangular, hollow cross sections, which are crafted as thin, mirrored waveguides plated with metal (commonly nickel). Under glancing angles with incoming neutrons, these waveguides can achieve nearly lossless transport of neutrons to distant instruments. Furthermore, recent developments have created supermirror surfaces which can accommodate neutron grazing angles up to four times as steep as nickel.

A completed system will form an enclosing ring or spherical resonator system to a coupled neutron source for the purpose of capturing and reusing free neutrons to sustain and/or accelerate fission. While grazing incidence mirrors are a known method of directing and safely using neutrons, no method has been disclosed for capture and reuse of neutrons or sustainment of fission using a circular waveguide structure. The presented work is in the process of fabricating a functional, highly curved, neutron supermirror using known methods of Ni-Ti layering capable of achieving incident reflection angles up to four times steeper than nickel alone. Parallel work is analytically investigating future geometries, mirror compositions, and sources for enabling sustained fission with applicability to the propulsion and energy goals of NASA and other agencies.

Should research into this concept prove feasible, it would lead to development of a high energy density, low mass power source potentially capable of sustaining fission with a fraction of the standard critical mass for a given material and a broadening of feasible materials due to reduced rates of release, absorption, and non-fission for neutrons. This advance could be applied to direct propulsion through guided fission products or as a secondary energy source for high impulse electric propulsion. It would help meet national needs for highly efficient energy sources with limited dependence on fossil fuels or conflict materials, and it would improve the use of low grade fissile materials which would help reduce national stockpiles and waste.