GEN IV International Forum℠
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TRISO Fuels

Summary / Objectives:

TRISO (TRi-structural ISOtropic) particle fuel has been developed for use in modular high temperature gas reactors (HTGR) designed to passively maintain core temperatures below fission product release thresholds under all licensing basis events and accident scenarios. This webinar will give an overview of the US DOE Advanced Gas Reactor (AGR) TRISO Fuel Qualification and Development Program's activities focused on enhancing TRISO fuel performance by using uranium oxicarbide (UCO) fuel kernels and improving coated particle and compact fabrication methods for deployment in advanced HTGRs. Topics include fuel characterization and qualification methods, TRISO production scale fabrication process improvements, AGR TRISO irradiation experiments, post-irradiation examination and safety heating test results, and fuel performance modeling efforts. Current US TRISO fuel reactor vendor efforts, and the first TRISO topical report submitted to the NRC will be presented.

Meet the Presenter:

Dr. Madeline Feltus has led the DOE Office of Nuclear Energy's Advanced Gas Reactor TRISO Fuels Qualification and Development Program since 2003. She provides technical support for DOE's advanced nuclear fuel research and development (R&D), light water reactor accident tolerant fuel R&D, and reactor development projects where she focuses on improving reactor fuels and materials irradiation performance for current and advanced fuel designs to have safe, accident-tolerant, robust, and reliable reactor fuel that can be used in existing and future advanced light water, gas-cooled, and sodium cooled reactors.

She has been involved in writing and providing input for OECD NEA Experts Committee reports, IAEA technical documents, and reviewing manuscripts for technical journals. She is responsible for managing various university grant projects, vendor/industrial projects and small business R&D efforts. Prior to joining DOE in 1999, Dr. Feltus was an assistant professor of nuclear engineering at the Pennsylvania State University (1991-1999). Madeline received her B.S. in Nuclear Engineering from Columbia University in 1977. While working full-time as a nuclear engineer at Burns and Roe, Public Service Electric and Gas (N.J.) and the New York Power Authority, she continued her graduate studies at Columbia and earned her M.S. in Nuclear Engineering (Reactor Physics, 1980), her M. Phil. in Mechanical Engineering (Thermal-Hydraulics, 1989) and her Ph.D. in Nuclear Engineering (1990) with her thesis on 3D time-dependent coupled kinetics-neutronics and thermal-hydraulics analyses.

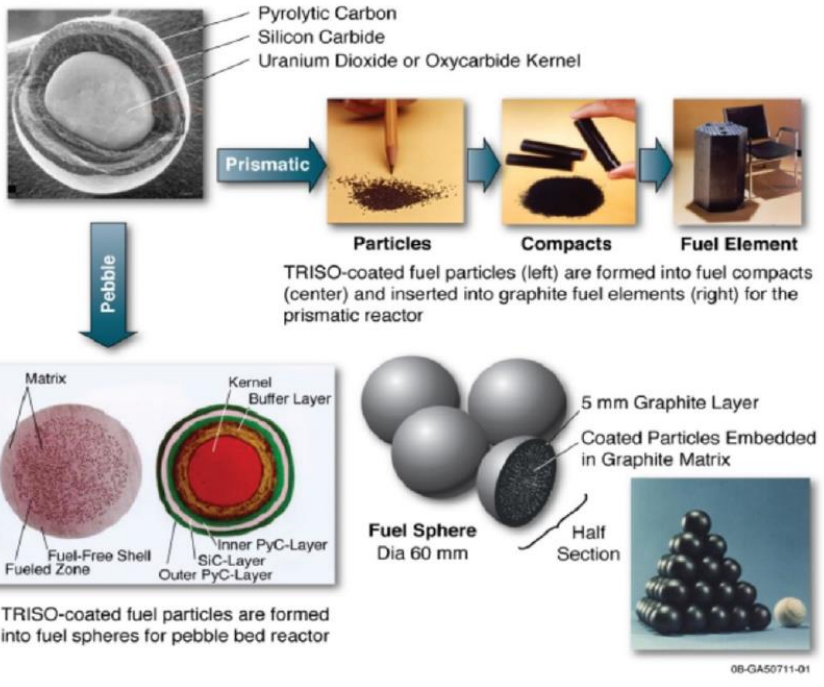
TRISO Particle Fuel:

TRI-Structural ISOtropic (TRISO) particles are embedded in graphite matrix material.

TRISO particles are embedded in graphitic matrix material

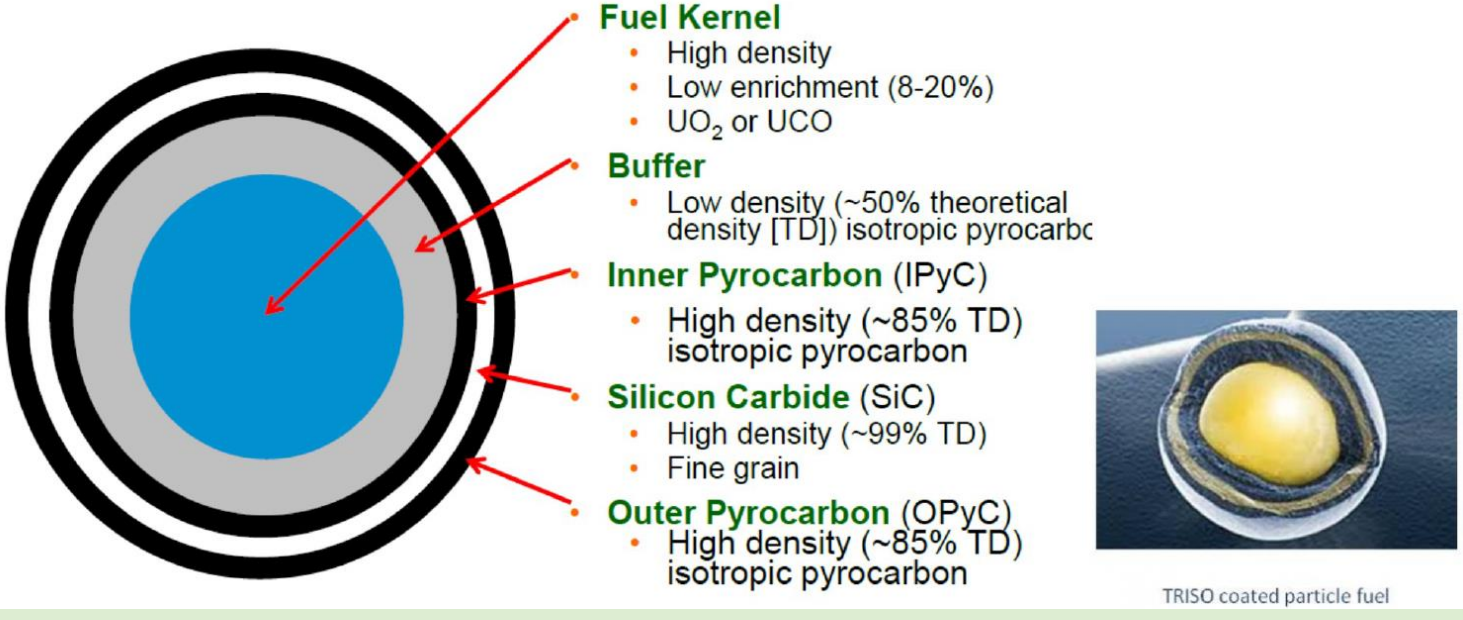
- Cylindrical compacts put hexagonal graphite blocks for prismatic reactor
- UCO fuel kernel for block or prismatic reactor with 12-19% U-235 enrichment
- Spheres for pebble bed reactor, flow through core
- UO_2 fuel kernel for pebble bed reactor with ~ 8 % enrichment (German)

Prismatic and pebble bed TRISO particle use similar coating layer thicknesses, but the kernel enrichment and particle packing fractions are different



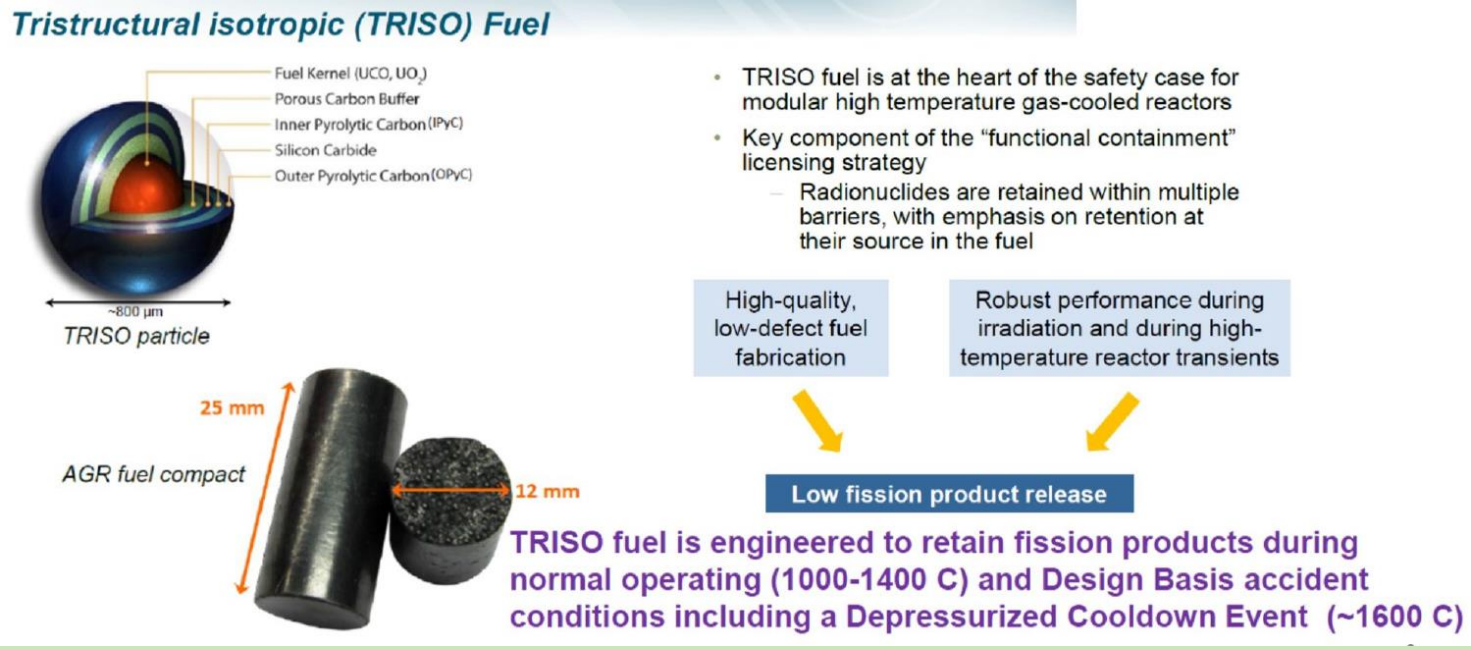
TRISO Particle Fuel Design:

TRISO particle fuel consists of fuel kernel, buffer, inner Pyrocarbon, Silicon Carbide, and outer Pyrocarbon.



TRISO Particle Coatings Retain Fission Products:

TRSO fuel is engineered to retain fission products during normal operating (1000°C-1400°C) and design basis accident conditions including a depressurized coolant event (-1600°C).

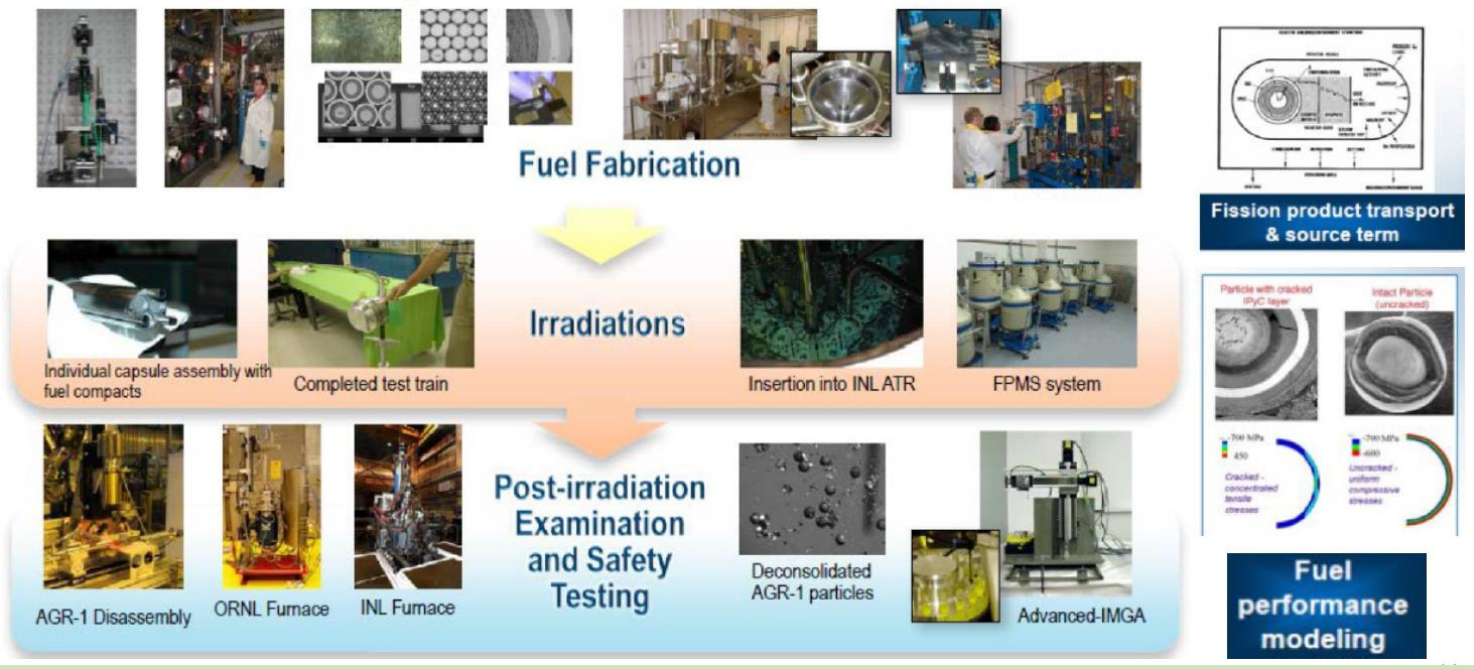


TRISO Particles act as individual fission product "Containments" for Gas-Cooled Reactors:

TRISO coated particle fuel performance and fission product retention is key factor for making the HTGR/VHTR/NGNP safety case.

Advanced Gas Reactor TRISO Fuel Qualification Program:

The objectives and motivation of the advanced gas reactor TRISO fuel qualification program in USA is to provide data for fuel qualification in support of reactor licensing and to establish a domestic commercial vendor for TRISO fuel.



Beyond the AGR TRISO Program:

TRISO fuel can be used in other reactor designs.

- Molten Salt-cooled (e.g., FLiBe, FLiNaK,) reactor concepts use graphite matrix TRISO fuel directly, e.g. Kairos Power based on University of California – Berkeley pebble bed design
- Fast Gas Reactors, using SiC or other non-graphitic matrix compacts
  - French helium fast gas design ZrO_2 coating
  - UC fuel kernels in metallic cladding
  - GA's EM^2 alternate design
- Encapsulated fuel for LWR Accident Tolerant Fuel
  - TRISO in SiC matrix with SiC tubes or Zircalloy cladding (ORNL)
- Fast sodium/metal cooled reactors
  - Dispersion fuels, TRISO-like fuel in metallic matrix, metallic clad
  - TRISO in SiC Mixed Oxide fuel pellets (FFTF or MOX cores)
- Extreme high temperature reactors using refractory metals, UC or UN fuels
  - Space reactors, or niobium (Nb), tantalum (Ta), molybdenum (Mo), rhenium (Re), vanadium (V) and tungsten (W) alloys.