

## Heterogeneity by design in engineered Micro-Nano hetero structures

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The development of novel nuclear-nano-materials found applications in nuclear fuels, and structural materials paving the way for near-perfect burnup, with minimal re-cladding and easy fuel processing, fission products self separation based on nuclear reactor kinematics, with easy separation, partitioning and dispositioning, transmutation products enhanced extraction assuring super grade purity, direct nuclear energy conversion in super-capacitor like structure charged from particle and radiation energy and discharged directly as electricity, and more.

A novel class of meta-materials and nano-structure is suitable for radiation and particle guiding with applications in nuclear structure criticality control, when equipped with NEMS, radiation imaging and non-imaging concentrators, radiation modulators, and super-light shielding by an order of magnitude thinner than the actual shielding.

In order to shield from radiation one may use the direct head-on collision between radiation particles and material resulting in shield's material structural damage, with high dpa, or may use a resonant absorption and re-emission of radiation similar to Mossbauer effect that to transform a directed radiation into an isotropic radiation, reducing its intensity towards the direction of interest.

Using this structure together with a super-capacitor like structure able to charge from nuclear particle energy and discharge electricity, may drive to the creation of a compact solid state nuclear reactor, a kind of fission battery, able to provide power at demand with exceptional criticality and power level control.