Exotic Metal Nuclear Synthesis for Jet-engines and Deep Cosmic-Space Challenges

Boris Udovic, Sezanska 11, 6210 Sezana, SLOVENIA

The exotic Rhenium (Re) metal (melting point 3180 °C) with its uncommon and yet widely unexplored properties is classified among the rarest metals in spite of the outstanding heat-resistant Wolfram-Rhenium (W-Re) super-alloys in jet-engines and advanced constructions with most demanding performances for deep-space explorations. The direct synthesis of the Re element in high temperature and low-volume kernel-milieu of fast nuclear reactors *via* natural Wolfram W(n,gamma) irradiation in high neutron flux regime constitute an accessible pathway realization to gain higher yields. Inside the extremely harsh environment of impinging fast hammering neutrons the fissile metal-carbide fuel matrix $MC_{(1+x)}$ with extra-added tetrahedral amorphous (ta-C) carbon atoms experiences continuously re-morphing processes of its disordered structure *via* generation and rapid cooling of hot carbo-radicals and dangling bonds. This dynamic 3D spiderlike carbo-carbide network is suitable to host additional multi-metal target atoms as the natural Wolfram and Beryllium by strong metal-carbide bonds. The lighter element Be improves this non-classic burn-up fuel-matrix as moderator to slow down the hot neutrons and enlarges the capture cross section of the natural W for low energy neutrons. However, the synergic action of hot neutrons on Be atoms provides to burst-out the fast multiplication effect of the (n, 2n) Beryllium reaction which gives an additional contribution to the total flux of hot neutrons for Rhenium higher speed production. Different actions with different fissile elements are yet still possible on Berillium atoms. The high energy alpha-particle emitter as Plutonium Pu(239) is versatile to knock-out hot neutrons from Be atoms to a great extent. This carbo-carbide matrix allows strong and short-distanced anchorages between the reactive nuclide-centers to overcome the low penetrability of the alpha rays. The spidery-composite carbo-web diminishes the poisoning effects of (n, alpha) reactions gained by the volatile daughter products. The trapped bubbles formation, growth and accumulation are avoided *via* rapid out-gassing and recovery of the precious Helium He(3) isotope formed in the chain sequence-decays from highly irradiated Be atoms.