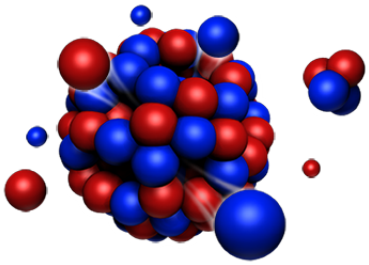

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Solid methane moderators: thermodynamics and chemistry

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The unique properties of solid methane enable the conversion of hot, energetic neutrons into cold neutrons, with an efficiency approximately 3.5 times that of liquid hydrogen based moderators. However, practical applications of solid methane in neutron moderators turned out to be much more challenging than initially expected. Exposure of solid methane at low temperatures to neutron radiation leads to a build-up of radiolysis products in the solid methane matrix. Accumulation of defects beyond some critical number can result in a spontaneous self-accelerated recombination process, which in combination with the expansion of hydrogen built up in bulk solid methane during irradiation, was believed to be responsible for the moderator's break-down. Here we present a thermodynamic model, based on theory of thermal explosion, which allows us to simulate this phenomenon. Our model agrees well with the test results and operational experience of running the ISIS Target Station 2 solid methane moderator. We also compare the results of our simulations with test data obtained using methane moderators developed at the IPNS neutron source, based at Argonne National Laboratory. In the second part of the presentation we discuss the products of radiolysis reactions generated by exposure of the condensed methane to neutron radiation. The succession of radiolysis reactions may lead to a production of long chain hydrocarbons, which can contaminate the moderator system and significantly reduce efficiency of the heat-exchanger. We also discuss possible solutions for cleaning moderators using targeting solvents.

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