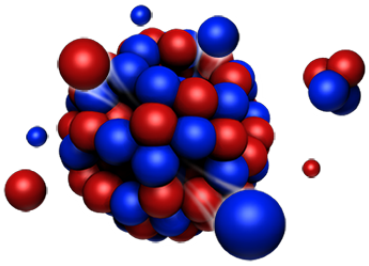

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Radiation chemistry of solid methane moderators

Thursday 17 October 2019 16:30 (2 hours)

Developing an understanding of the effects of neutron radiation in solid methane is of key importance for operations at spallation neutron sources. Solid methane is an excellent moderator material, efficiently enabling the conversion of hot neutrons into cold. However the use of solid methane moderators has so far proven challenging, due to the 'burp'effect [1]. Radiolysis products build up in the frozen methane, until a critical concentration of radicals is reached –after this point spontaneous, exothermic radical recombination reactions occur, causing an uncontrolled spike in temperature and pressure.

A side effect of this phenomenon is the accumulation of progressively larger hydrocarbon molecules in the moderator. The radical recombination reactions which cause 'burping'also produce hydrocarbons containing two or more carbon atoms. With continued moderator use these build up, and carbon chain length increases, until eventually a thin coating of heavy hydrocarbons is formed on the inner surface of the moderator's heat exchanger. The heat transfer capability of the moderator gradually worsens until the process is so inefficient as to make continued use of the moderator at low temperature impossible.

In this poster we outline key reaction pathways which lead to the build-up of heavy hydrocarbons in methane moderators. We present our strategies for chemical analysis of solid methane radiolysis products, and suggestions for moderator life extension.

[1] J. M. Carpenter, Nature, 330, 358 (1987)

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