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HyDUS Project; Seeking a Wonder Material for Hydrogen Storage

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Abstract : Hydrogen, as a clean alternative to methane, is relatively easy to make, either from water using electrolysis or from methane using steam reformation. However, hydrogen is much trickier to store than methane, and without effective storage, it simply won't pass muster as a suitable methane substitute. Physical storage of hydrogen is quite inefficient. Storing hydrogen as a compressed gas at pressures up to 900 times atmospheric is volumetrically inefficient and carries safety implications, whilst storing it as a liquid requires costly and constant cryogenic cooling to minus 253°C. This is where DU steps in as a possible solution. Across the periodic table, there are many different metallic elements that will react with hydrogen to form a chemical compound known as a hydride (or metal hydride). From a chemical perspective, the 'king' of the hydride forming metals is palladium because it offers the highest hydrogen storage volumetric capacity. However, this material is simply too expensive and scarce to be used in a scaled-up bulk hydrogen storage solution. Depleted Uranium is the second most volumetrically efficient hydride-forming metal after palladium. The UK has accrued a significant amount of DU because of manufacturing nuclear fuel for many decades, and that is currently without real commercial use. Uranium trihydride (UH3) contains three hydrogen atoms for every uranium atom and can chemically store hydrogen at ambient pressure and temperature at more than twice the density of pure liquid hydrogen for the same volume. To release the hydrogen from the hydride, all you do is heat it up. At temperatures above 250°C, the hydride starts to thermally decompose, releasing hydrogen as a gas and leaving the Uranium as a metal again. The reversible nature of this reaction allows the hydride to be formed and unformed again and again, enabling its use as a high-density hydrogen storage material which is already available in large quantities because of its stockpiling as a 'waste' by-product. Whilst the tritium storage credentials of Uranium have been rigorously proven at the laboratory scale and at the fusion demonstrator JET for over 30 years, there is a need to prove the concept for depleted uranium hydrogen storage (HyDUS) at scales towards that which is needed to flexibly supply our national power grid with energy. This is exactly the purpose of the HyDUS project, a collaborative venture involving EDF as the interested energy vendor, Urenco as the owner of the waste DU, and the University of Bristol with the UKAEA as the architects of the technology. The team will embark on building and proving the world's first pilot scale demonstrator of bulk chemical hydrogen storage using depleted Uranium. Within 24 months, the team will attempt to prove both the technical and commercial viability of this technology as a longer duration energy storage solution for the UK. The HyDUS project seeks to enable a true by-product to wonder material story for depleted Uranium, demonstrating that we can think sustainably about unlocking the potential value trapped inside nuclear waste materials.

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