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#8-132 Next-Generation Hydrogen Mitigation Technology for Nuclear Safety

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A Loss of Coolant Accident (LOCA) in a nuclear reactor, where coolant levels drop significantly, can lead to core overheating and hydrogen generation through chemical reactions between the hot zirconium cladding and water. However, LOCA is not the only scenario where hydrogen production becomes a concern. Severe overheating, core melt scenarios, and even the radiolysis of water by intense radiation can also lead to hydrogen buildup within the reactor containment. Rising hydrogen concentrations present a significant explosion risk, as evidenced by historical accidents such as Three Mile Island and Fukushima-Daiichi.

To mitigate these risks, modern reactors are equipped with hydrogen management systems like Passive Autocatalytic Recombiners (PARs) and hydrogen igniters. However, during a reactor accident, hydrogen production can increase rapidly, pushing these devices to their operational limits. Additionally, high temperatures and elevated steam levels can contaminate and reduce their effectiveness. This limitation is particularly concerning in reactor accidents, where hydrogen accumulation can potentially compromise reactor containment.

In this work, we present a highly efficient approach developed at the CEA to improve current hydrogen management systems. This passive technology uses autocatalytic amplification to significantly accelerate the hydrogen recombination process. Advanced materials are also employed to enhance the active surface area, greatly increasing reaction rates and enabling efficient recombination even at low concentrations of hydrogen and oxygen. These materials can withstand high radiation levels and temperatures up to 500 °C, providing a more robust solution for managing hydrogen-related risks in severe reactor accident scenarios.

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