405b Characterization of Candidate Ceramic Materials for the High Temperature Sulfuric Acid Loop in the Si Process

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The Sulfur-Iodide (SI) process has been investigated extensively as an alternate process to generate hydrogen through the thermo-chemical decomposition of water. The commercial viability of this process hinges on the durability and efficiency of heat exchangers/decomposers that operate at high temperatures under corrosive environments. In cooperation with the DOE and the University of Nevada, Las Vegas (UNLV), ceramic based micro-channel decomposer concepts are being developed and tested. The performance benefits of a high temperature, micro-channel heat exchanger are realized from the thermal efficiency due to improved effectiveness of micro-channel heat and mass transfer and the corrosion resistance of the ceramic materials. Although the overall design and validation of a ceramic decomposer includes corrosion testing, thermal-hydraulics modeling, mechanical stress modeling and empirical validation testing, this paper focuses on the corrosion and mechanical property evaluation of candidate ceramic materials. The development of the materials to be integrated into these micro-channel devices can follow a parallel development path, wherein the best suited material is inserted into the manufacturing process once qualified. The primary design criterion consists of the corrosion properties (hot gaseous sulfuric acid) and the mechanical properties (strength as a function of exposure). In order to assess these properties, samples were exposed to simulated high temperature constituents (acid, water and oxygen). The effect of exposure on weight gain and mechanical properties was examined. Additionally, surface and depth profiling was done using high resolution electron microscopy. The results of these corrosion studies will be presented. Additional discussions will compare the expected life and possible failure mechanisms of the candidate materials.