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C2Po3D-04: Catalytic materials for ortho-parahydrogen conversion in a thermoacoustic cryocooler regenerator

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Pulse tube cryocoolers utilize pressure waves oscillating within a porous regenerator for active refrigeration. Using hydrogen instead of helium as the working fluid provides increased refrigeration performance over a range of operational conditions due to lower viscous dissipation. Hydrogen also provides the potential to augment the cooling capacity via ortho- to parahydrogen conversion which can absorb or release up to 702 kJ/kg. The practical design aspects of regenerators and catalyzation reactors are synergistic, however this synergy has not been investigated. To achieve both catalyzation and high regenerator effectiveness the material must meet three key aspects: high heat capacity, high thermal conductivity, and the ability for the surface to be oxidized to induce catalyzation. This study investigates the catalytic activity and regenerator performance of 2.5-mm-diameter spheres of oxidized iron, brass, and stainless steel. Acoustic onset temperatures of the system including a thermoacoustic engine, pressure amplitudes, no-load cooling temperatures, and ortho-parahydrogen conversion activity are reported. The goal of this study is to aid in optimization of a catalyzed thermoacoustic regenerator where lower viscous losses are paramount to cooling efficiency.

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