Contribution ID: **91** Type: **Poster Presentation**

An investigation on the Application of ErPr Packed Sphere Matrix in Stirling Type Pulse Tube Cryocooler

This paper introduces a new kind of packed sphere matrix made with ErPr, and analyzes the application in Stirling type pulse tube cryocooler. In pulse tube cryocoolers, ideal regenerator requires regenerator matrix high in specific heat, low in flow resistance and conductive heat loss. However, below the liquid hydrogen temperature the specific heat of stainless steel decreases significantly, while that of helium rises as the temperature decreases from 25 K to 10 K. This makes the regenerator low in efficiency. Due to the magnetic phase transition, the specific heat of ErPr rises at the temperature of 30 K as the temperature decreases, which makes it superior to other regenerator matrix materials in specific heat at low temperature. To understand the material better, experiments have been designed to test the thermal conductivity and flow resistance of porous media. Several kinds of regenerator matrix materials have been tested and compared in thermal conductivity. The flow resistance of packed sphere matrix in different sizes has been measured at both low and ambient temperature. To analyze the application of ErPr in Stirling type cryocooler, a co-axial multi-bypass Stirling type pulse tube with ErPr made regenerator has been modeled and analyzed in commercial software.

This research is supported by The National Natural Science Foundation of China (No. 51327806 and No. 51427806).

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Track Classification: CEC-05 - Expanders, Pumps, Compressors, and Regenerators