

Optimizing of regenerator materials for a high-frequency pulse tube cryocooler working below 3 K

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Limited by insufficient cold storage capacity of regenerator materials, especially operating below 10 K, it is challenging for a high-frequency pulse tube cryocooler to obtain a low temperature down to liquid helium temperature. In this study, the influence of different regenerator materials on the refrigeration performance of a high-frequency regenerator working in the liquid-hydrogen to liquid-helium temperature ranges was investigated primarily by detailed numerical simulation. Besides, the design and optimization direction of the low-temperature regenerator was outlined. Based on simulation results, a three-stage high-frequency pulse tube cryocooler with composite thermal-coupled and gas-coupled refrigeration process was designed, built, and tested. Using 4He as the working gas, a no-load temperature below 3 K was experimentally obtained, and a cooling power of around 20 mW at 4 K can be provided.

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