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Experimental investigation on regenerator materials of Stirling-type pulse tube refrigerator working at 20 K

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Regenerator, a most important part of pulse tube refrigerator (PTR), must be carefully designed especially when working at high frequency and ultra-low temperature. In process of selecting regenerator materials, much attention is paid on the heat capacity of regenerator materials, while thermal conductivity is always omitted. In this paper, an effort will be made on explaining how thermal conductivity makes a difference on the performance of PTR.

Experimentally, we will report on a detailed study in the various kinds of regenerator materials working at liquid hydrogen temperature, such as lead spheres, Er₃Ni, HoCu₂, and high-mesh number stainless steel, which are of different heat capacity and thermal conductivity. A systematical performance of the refrigerator with different regenerator materials will be presented. We will make a possible interpretation to clarify the results.

Combined with experimental results, a theoretical analysis will be made to explain how thermal conductivity will impact the performance of the refrigerator. Finally, to sum up a guide line for future experiments, a parameter will be proposed, according to which one can select the most promising kind of regenerator materials.

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