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Numerical studies on the phase adjustment systems of high frequency pulse tube cryocooler with a gradient temperature distribution

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Some single-stage high-frequency pulse tube cryocoolers (HPTCs) have been developed in recent years. At present, with an electric input power of 250 W and a frequency of 30 Hz, the lowest temperature achieved is around 15 K and the typical cooling capacity is about 350±50mW/ 20 K. Although single-stage is more attractive to customers compared with multi-stages because of its mechanical simplicity, it is difficult to achieve lower temperature, thus the employment of double-stage is a compromise approach. At the beginning of structure design, the liquid nitrogen (LN2) was employed as the pre-cooling stage to cool the hot end of the HPTC that has been developed in our lab. In the aspect of compactness and simplification, coaxial configuration has been adopted, and the inertance tube was arranged passing through the compressor internal space and wrapped in the reservoir, integrating the reservoir, pulse tube and compressor together .Therefore, a gradient temperature distribution from the liquid nitrogen temperature to room temperature is set up along the inertance tube. Furthermore, in order to reduce the adjustment difficulty, the double-inlet was also installed at the position of room temperature. Thus, for the gases, passing through the double inlet and then flowing into the pulse tube is also a process of temperature changes. Through some preliminary experiments, we discovered that the mechanism of the phase adjustment systems with a gradient temperature distribution is different from that with uniform temperature distribution. In this paper, the mechanism of the phase adjustment systems with temperature gradient will be numerical studied, and some preliminary experimental results will be presented.

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