Development of a High Efficiency Pulse Tube Cryocooler Using Room Temperature Displacers for HTS Applications

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The compact and high efficiency coolers working in the liquid nitrogen temperature region play an important role in HTS Applications. Stirling type pulse tube cooler servers as a promising candidate for cooling HTS devices for its advantages such as low vibration, high reliability and low cost due to absence of the moving parts in the cold head compared with traditional coolers. However, phase shift mechanisms used in a conventional pulse tube cryocooler need to dissipate expansion power at the ambient end of the pulse tube, which leads to a lower thermodynamic efficiency than that of a Stirling cryocooler. In order to improve the efficiency and obtain a reliable cryocooler system, this article presents a pulse tube cryocooler which uses room temperature displacers as the phase shifter, which aims at providing more than 10 W cooling power at 77 K. The cryocooler with a model number of TC4189 consists of linear compressor, coaxial pulse tube and two dual-opposed ambient displacers. High pressure ratio and high frequency operation are used to increase the power density. The whole system has a total mass of 4.3 kg. At an optimum working point, a lowest no-load temperature of 44 K has been obtained and the cooling power at 80K reaches 15 W with an input electric power of 240 W, which means an efficiency of 17.1% of Carnot. The influence of displacers operating and structural parameters were investigated through simulations and experiments.