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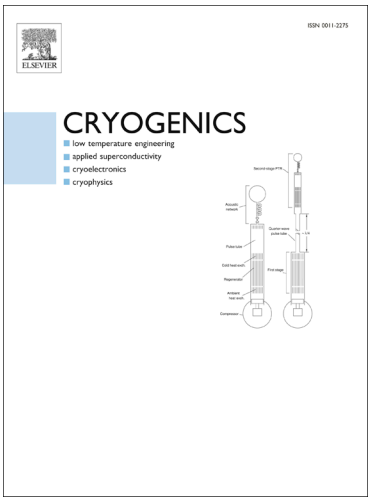

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A high efficiency coaxial pulse tube cryocooler operating at 60K

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Abstract: In recent years, improved efficiency of pulse tube cryocoolers has been required by some space infrared detectors and special military applications. Based on this, a high efficiency single-stage coaxial pulse tube cryocooler which operates at 60K is introduced in this paper. The cryocooler is numerically designed using SAGE, and details of the analysis are presented. The performance of the cryocooler at different input powers ranging from 100W to 200W is experimentally tested. Experimental results show that this cryocooler typically provides a cooling power of 7.7W at 60K with an input power of 200W, and achieves a relative Carnot efficiency of around 15%. When the cooling power is around 6W, the cryocooler achieves the best relative Carnot efficiency of around 15.9% at 60K, which is the highest efficiency ever reported for a coaxial pulse tube cryocooler.

Keywords: pulse tube cryocooler; coaxial; infrared detector; 60K

1. Introduction

Long-wave HgCdTe infrared detectors can work effectively at temperatures around 60K. Due to the rapid advance of space infrared technology, infrared detectors have evolved to large-scale focal plane arrays, which require a large cooling power, up to 6W at around 60K. Because of the limited power resources in space, there is an urgent demand for high efficiency space cryocoolers operating at 60K.

Due to the absence of moving parts in cold finger, pulse tube cryocoolers (PTCs) have low vibration and long lifetime, which is important for space instruments. The first PTC was developed in 1963 by Gifford [1], which had an extremely low efficiency at that time. However, in the past decades, much effort has been made to improve the efficiency of PTCs, and the recently reported PTCs have efficiencies approaching that of Stirling cryocoolers. In 1996, TRW [2] developed the TRW 6020, which delivered 2.0W at 60K with an input power of 76W and obtained a relative Carnot efficiency of 10.5%.