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Miniature Piezoelectric Compressor for Joule-Thomson Cryocoolers

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Joule-Thomson (JT) cryocoolers operate with a continuous flow of the working fluid that enters the cooler at a high pressure and leaves it at a lower pressure. Ideally, the temperature of the outgoing fluid equals the temperature of the entering fluid. JT cryocoolers that operate with pure refrigerants require high pressure of a few tens of MPa where the low pressure is usually around 0.1 MPa. Circulation of the working fluid in such cases requires high pressure ratio compressors that evidently have large dimensions. JT cryocoolers can operate with much lower pressure ratios by using mixed-refrigerants. Cooling from 300 K to about 80 K in a single stage cryocooler normally requires pressure ratio of about 1:25.
In the present research a miniature compressor driven by piezoelectric elements is developed in collaboration between Rafael and the Technion. This type of compressor has the advantage of improved long life compared to other mechanical compressors, very low vibrations, and silent operation. In the current case, the design goal of the intake and discharge pressures has been 0.1 and 2.5 MPa, respectively, with a flow rate of 0.06 g/s. The compressor has two compression stages; 1:5 and 5:25.
Several configurations have been considered, fabricated, and tested. The performance of the last configuration approaches the desired specification and is presented in the current paper together with the design concept.

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