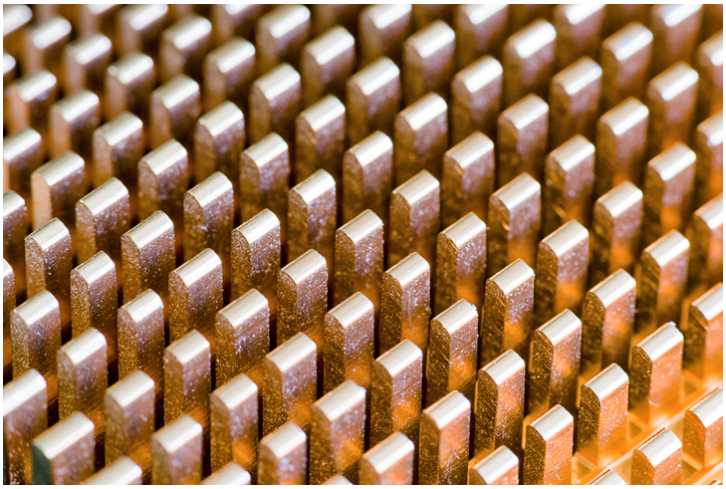
INNOVATION PARTNERSHIPS
UNIVERSITY OF MICHIGAN

Silicon Micromachined High Flow Gas Pump

TECHNOLOGY NUMBER: 6502



Technology ID
6502

Category
Hardware
Engineering & Physical Sciences

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OVERVIEW

High-flow Knudsen pump with vertical Al2O3 channels in SOI

- Provides high-flow generation without moving parts
- Gas chromatography systems, micro-vacuum systems, improved gas flow management

BACKGROUND

Knudsen pumps, based on thermal transpiration, generate gas flow without moving parts by creating a temperature gradient along narrow channels. Historically, most gas micropumps have relied on mechanisms like electrostatic, piezoelectric, or electromagnetic actuation, which involve flexible diaphragms that can suffer from stress and fatigue, leading to potential mechanical failure. A significant limitation of previous Knudsen pumps was their low flow rates, even though they could achieve high vacuum levels. Earlier efforts used either in-plane channels or porous media; however, in-plane channels offered limited flow rates due to serial configuration while porous media, although providing higher flow, suffered from inconsistent channel quality causing leakage and decreased efficiency. Therefore, there's a need for an improved design with high-density, vertically oriented channels to achieve high flow and maintain the structural advantages of Knudsen pumps.

INNOVATION

Researchers at the University of Michigan have developed a monolithic high-flow Knudsen pump utilizing vertically oriented Al2O3-lined channels fabricated in a silicon-on-insulator (SOI)

wafer. The innovation lies in the microfabrication of high-density thermal transpiration channels with precise, uniform dimensions achieved through a controlled lithographic process. These channels allow for efficient parallel pumping, significantly increasing the flow rate while maintaining the benefits of having no moving parts. The use of atomic layer deposition (ALD) to create thin Al2O3 sidewalls optimizes thermal insulation and reduces power consumption. Real-world applications of this technology include providing consistent air flow in micro gas chromatography systems, enhancing vacuum systems, and other applications requiring reliable gas flow management. Experimental results demonstrate an impressive air flow rate exceeding 200 sccm at atmospheric pressure, showcasing its potential to replace traditional diaphragm-based micropumps.

ADDITIONAL INFORMATION

REFERENCES

S. An, Y. Qin and Y. B. Gianchandani, "A Monolithic High-Flow Knudsen Pump Using Vertical Al2O3 Channels in SOI," in Journal of Microelectromechanical Systems, vol. 24, no. 5, pp. 1606-1615, Oct. 2015, doi: 10.1109/JMEMS.2015.2426699

INTELLECTUAL PROPERTY

US10794374 "Microfabricated gas flow structure"