Chip Scale Micro Pump for Achieving High Vacuum
Technology #13724

Applications

- Portable mass spectrometer
- Vacuum nano-electronic amplifiers
- Sensors, including atomic sensors based on spectroscopy of alkali atoms

Problem Addressed

Chip-scale systems such as sensors and analyzers that operate in a vacuum environment offer entirely new capabilities, such as rapid, portable detection of chemical warfare agents, but even with the potential they offer in portability, their practical application is limited by the size of the pumps that evacuate the air from the system. To date, the state of the art for evacuating chip-scale devices to high vacuum remains the macroscale vacuum pump. Chip-scale displacement pumps for vacuum pumping exist but are challenged to reach even the lower end of the low vacuum range. Plasma-driven chip-scale ion pumps have also been demonstrated for pumping down from atmospheric pressure, but their demonstrated base pressures remain in the low vacuum range.

Technology

The technology presents a solution to the chip scale pumping problem. The technology is a compact, multi-stage system where each stage utilizes a different technology to reduce the pressure from atmospheric to the required $10^{-6}$ Torr. The stages are as follows: (1) A displacement pump lowering the pressure from atmospheric (760 Torr) to the 10-30 Torr range, (2) a field ionization-driven pump that uses carbon nanotube (CNT) concentrators to ionize molecules lowers the pressure to 1-10 mTorr range, (3) an electron impact ionization-driven pump which ionizes molecules through electron collisions and brings down the pressure in the chamber down to $10^{-6}$ Torr.

This bare technology addresses the challenge posed by the limitation of pump size in chip-scale devices, but vacuum leakages reduce the longevity of the system. To fix this issue a micro-valve is used between the mechanical pump and the ion pump to increase the life expectancy of the system.

Advantages

- Operating Ion pumps in the low pressure regime increases longevity substantially
- Devices are fabricated for low cost production with tight specs
- Minimum number of moving parts allows simplified and robust operation
- Series of pumps covers eight orders of magnitude of pressure

Categories For This Invention:

- Photonics
- Sensors (Photonics)
Life Sciences
Instrumentation
Mass Spectrometry

**Intellectual Property:**

Single-use, permanently-sealable microvalve
Issued US Patent
9,388,916

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**Publications:**

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**External Links:**

Microsystems Technology Laboratories  
http://www-mtl.mit.edu/
Velasquez-Garcia Group
http://www-mtl.mit.edu/wpmu/lfv/
Schmidt Research Group
http://schmidtresearchgroup.mit.edu/

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