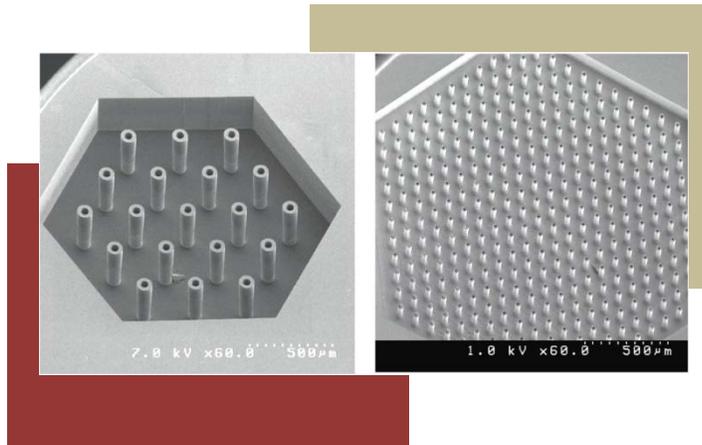


TECHNOLOGY FACT SHEET

NOVEL FABRICATION OF AN IMPROVED, INTEGRATED ELECTROSPRAY ATOMIZER

Introduction

This invention showcases a substantial advance in electro spray technology. Researchers at the Sensors and Electron Devices Directorate of the U.S. Army Research Laboratory (ARL), Adelphi, Maryland, successfully developed and tested novel improvements to a recent electro spray atomizer design and devised precision wafer fabrication processes. These advancements result in faster, higher-quality production of compact multiplexed spray devices that contain all components in a single integrated package. Such a mechanism has been unavailable previously in the electro spray marketplace.



Improved multiplexed spray atomizer featuring ARL improvements that enable smaller feature geometries (Image source: ARL)

Concept

Liquid fuel injection strategies are critical to small-scale portable power systems that are based upon either direct combustion or fuel reforming. Combustion takes advantage of significantly higher energy densities available in liquid hydrocarbons and alcohols. For example, 1-butanol contains about ten times greater energy per gram than conventional primary batteries. Harnessing such potential in a portable format could significantly reduce carrying weight for Soldiers, first responders, and others with similar power needs. However, scaling combustor volume down to the cubic centimeter range requires that the fuel be delivered in the form of small, rapidly evaporating droplets. The ARL invention, an improved multiplexed electro spray as illustrated above, achieves this critical goal by making use of the science of electro-hydrodynamics and a dense array of nozzles fabricated into a single integrated package. This novel technology has proven effective, atomizing liquid fuel for compact power applications.

Invention Overview

- ❖ Novel improved device produces a carefully controlled dispersed droplet array from a variety of fluids
- ❖ Novel fabrication process takes advantage of precision semiconductor manufacturing techniques
- ❖ Multiple fields of use, including power generation, spray deposition, vehicle propulsion
- ❖ TRL 5 – Fully functioning laboratory prototypes and test data available
- ❖ Additional information – “Demonstration of Ethanol and JP-8 Fuel Atomization Using Micromachined Silicon Multiplexed Electro sprays” ARL-TR-4816, May 2009; “Multiplexed electro spray scaling for liquid fuel injection” J. Micromech. Microeng. 20 (2010)
- ❖ U.S. Patent application 12/199,032

Doing Business with ARL

- ❖ ARL is a leader in partnering with domestic firms
- ❖ Successfully developed and implemented innovative tools to ease the technology transfer process
- ❖ Tools include Patent License Agreements (PLAs); Cooperative Research and Development Agreements (CRADAs); Test Services Agreement (TSA); and others
- ❖ Visit www.arl.army.mil for more information

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Features/Capabilities/Intellectual Property

Recently, university researchers verified that multiplexed electro spray is an effective way to break up heavy hydrocarbon fuels into fine droplets. Their device delivered high flow rates by achieving a high density of nozzles (250 per cm^2). However, the unit was created using a combination of manually assembled micro-machined and conventionally machined components. Further reduction in the size of this device was restricted by the manual assembly technique—a time-consuming, painstaking process fraught with potential error.

The ARL method of fabricating the multiplexed electro spray has several distinct advantages over the current process. Most significantly, the entire production—fabrication, alignment, and assembly of the complete device—is performed at the wafer level using automated, high-precision micro-electromechanical system manufacturing (MEMS) techniques. This technique significantly expands design options, allowing for greater nozzle densities per wafer and improving the quality and production throughput of finished products. Other features/capabilities/intellectual property offered by the ARL invention include the following:

- Higher alignment tolerances allow devices with smaller feature geometries
- Design improvements include integrated fuel/fluid reserve and elimination of spacer wafer
- IP includes novel fabrication method and two different assembled devices



Improved multiplexed spray atomizer could enhance performance of SOFC auxiliary power units being tested by Army for armored vehicles. (Image source: U.S. Army)

Potential Markets/Applications

Numerous applications have been found for electro spray atomization. The most successful thus far may be as an ion source for mass spectroscopy of large biomolecules. Another promising application is fuel reforming for solid oxide fuel cells, which are now being tested by the U.S. Army as auxiliary power units for armored vehicles, such as the M-1 Abrams tank shown above. There are many other developing potential applications:

- Aerosol generation
- Fiber formation by electrospinning
- Spray deposition
- Etching and printing

Key Advantages & Benefits

- ❖ *Compact spray atomizer achieves flow density of about 2500 cc/hr/ cm^2 for 1-butanol while operating at the minimum flow rate per nozzle*
- ❖ *Construction materials are inexpensive and widely available*
- ❖ *Fabrication method is uncomplicated and amenable to high-volume production*
- ❖ *Inventor is available to work with commercialization partner*

Contact Information

This technology was developed by ARL. It is now available for licensing and CRADA opportunities.

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