



Precision Combustion, Inc.

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Microlith® Fast Lightoff Catalytic Converters

DESCRIPTION OF THE TECHNOLOGY

With support from the Environmental Protection Agency's (EPA) Small Business Innovation Research (SBIR) Program, Precision Combustion, Inc. (PCI) has developed the Microlith® Fast Lightoff Catalytic Converter that offers an economical approach to significantly reduce automotive combustion emissions and has found numerous additional applications where its unique operational characteristics offer reactor design advantage. PCI's Microlith® catalytic converter includes novel substrate geometry, which offers high mass and heat transfer, together with a complementary coating system. The resulting reactor is small and lightweight, and exhibits rapid thermal response. The improved mass transfer provides high conversion efficiency, allowing substantial reduction in converter volume, weight, and the amount of precious metal required. The high heat transfer and lower weight of the substrate provide very rapid thermal response, reaching inlet gas temperatures within 1 second. These attributes make the Microlith® substrate ideal for high-performance catalytic converter applications as well as for various burner and fuel reforming reactors used to create hydrogen and/or syngas from hydrocarbon fuels.

SIGNIFICANCE OF THE TECHNOLOGY

Regulations governing automotive emissions in the United States are increasing in number and stringency, and there is a constant need for technological innovation to reduce emissions levels as more vehicles are produced with longer

useful lifetime requirements. Current technology for auto emissions control consists primarily of ceramic-based catalytic converters in the exhaust system. Although these catalytic converters are 95 percent effective once they reach operating temperature (after "lightoff"), they are ineffective during the first 1 to 2 minutes following engine startup. As a result, approximately 80 percent of automotive hydrocarbon and carbon monoxide emissions are released during the initial period of a typical drive. Because PCI's Microlith® preconverter helps control these startup emissions when combined with a three-way main converter, it is capable of achieving an 80 percent reduction in emissions of hydrocarbons and carbon monoxide, and a 50 percent reduction of nitrogen oxide emissions compared to a conventional catalytic converter alone.

As a lightoff converter, or preconverter, used in conjunction with a conventional main converter, Microlith® substrate technology offers the potential for achieving Ultra Low Emission Vehicle (ULEV) performance using a device one-fourth the volume of conventional advanced technology lightoff converters with much less catalyst used. PCI also has developed a smaller, less expensive lightoff converter that achieves Low Emission Vehicle performance as a stand-alone unit. The effectiveness and durability of the Microlith® catalytic converter have been demonstrated in prototype tests conducted at the Ford Motor Company (successfully demonstrated ULEV emissions from an Escort), other major auto manufacturers, and automotive suppliers. Comparative laboratory tests

SBIR Impact

- ◆ The Microlith® Fast Lightoff Catalytic Converter, when used in conjunction with a conventional automotive main converter, is capable of achieving a greater than 80 percent reduction in emissions of hydrocarbons and carbon monoxide, and a 50 percent reduction of nitrogen oxide emissions.
- ◆ The Microlith® is substantially smaller in volume and weight than conventional converters and requires considerably less precious metal.
- ◆ The rapid thermal response characteristics as well as the small size and low weight of Microlith® substrate versus competing technologies are an important attribute to enable the development of on-board fuel reforming for automotive fuel cells.
- ◆ Microlith®-based decomposition reactors enable the development and use of lower polluting aerospace propulsion.



PCI's automotive Microlith® converter and main converter assembled in an integrated can (left). A model of a stand-alone Microlith® automotive preconverter (right).



PCI's Microlith® automotive preconverter undergoing a hot vibration test (100 Hz, 28 g, at 950°C for 150 hours).

between conventional ceramic monolith and Microlith® substrates have shown that with a 20-fold reduction in converter volume, the Microlith® substrate delivers equivalent mass transfer-limited conversion. The Microlith® catalytic converter also reaches 350°C lightoff temperatures in less than 1/20th the time required for a conventional automotive ceramic monolith.

PCI has found multiple uses for the Microlith® substrate. Catalytic converter applications include marine four-stroke engine, natural gas internal combustion engine, and small two-stroke utility engine emissions reduction. Department of Defense applications include use as infrared signal generators for aerial target drones and for hydrogen peroxide decomposition for various military and propulsion applications. Participating in the genesis of the hydrogen economy, PCI has found increasing interest in Microlith®-based catalytic reactors for use in the various aspects of fuel reforming for fuel cells such as for catalytic partial oxidation, water gas shift, and preferential oxidation reactions, as well as for reformer start burners and fuel cell anode gas burners.

COMMERCIALIZATION SUCCESS

Award of the EPA SBIR contract helped PCI attract substantial industrial investment that has advanced the Microlith® technology along the path of large-scale production. Because of the value that Microlith® substrates

have demonstrated as a platform technology, PCI has focused its commercialization efforts on tailoring the technology for specific product application, manufacturing process development, and provision of prototype samples for testing to potential customers and partners. PCI has 13 issued patents on this technology and others pending. PCI already has received investment for spin-off applications (e.g., industrial fume abatement, clean burners, fuel reformers, etc.) from private industry as well as the National Aeronautics and Space Administration, the U.S. Air Force, the U.S. Army, and the National Science Foundation.

AWARDS AND COMPANY HISTORY



In recognition of its significant achievement in developing the Microlith® Fast Lightoff Catalytic Converter and other innovative environmental technologies, PCI received EPA's prestigious Environmental Technology Innovator Award in March 1998. Later that year, PCI also was selected as a recipient of the Tibbetts Award from the Office of Technology, U.S. Small Business Administration, in recognition of its unique contributions as a "Small Business Innovation Research Model of Excellence." PCI also was selected by Deloitte & Touche as a member of the Connecticut "Fast Fifty," in recognition of its status as one of the fastest growing technology companies in that state during the years 1998-2001.

What is the SBIR Program?

EPA's Small Business Innovation Research (SBIR) Program was created to assist small businesses in transforming innovative ideas into commercial products. The SBIR Program has two phases—Phase I is the feasibility study to determine the validity of the proposed concept and Phase II is the development of the technology or product proven feasible in Phase I. EPA also offers Phase II Options to accelerate the commercialization of SBIR technologies and to complete EPA's Environmental Technology Verification (ETV) Program. For more information about EPA's SBIR Program and the National Center for Environmental Research, visit <http://www.epa.gov/ncer/sbir>.