

# Fast Lightoff Catalytic Converter for Reduced Combustion Emissions

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## Environmental Problem

Mobile sources such as cars, trucks, and buses are the primary contributors to air pollution and are a major source of carbon dioxide (CO<sub>2</sub>). Automotive catalytic converters efficiently consume unburned hydrocarbons, carbon monoxide, and nitrogen oxides (NO<sub>x</sub>), substantially cutting engine emissions, but take time after engine start to heat up enough to work. Before Precision Combustion Inc.'s (PCI) research and development, approximately 80% of remaining automotive emissions occurred during the startup period, before the main converter would heat up enough to become effective and "lightoff." This delay is common to all catalytic reactors.

## SBIR Technology Solution

With support from EPA's Small Business Innovation Research (SBIR) Program, PCI developed the Microlith<sup>®</sup> fast lightoff converter technology for automotive applications, demonstrating fast lightoff operation (including ultra low emission in an Escort tested by Ford in 1993) among other features, and making a pioneering contribution to industry automotive fast lightoff technology. PCI's Microlith<sup>®</sup> catalysts use wire mesh-type substrates, specialized coatings, and unique reactor designs to achieve quick lightoff though very high rates of heat and mass transfer to and from a short contact time cat-

alytic surface. The resulting reactor is small and lightweight, and begins to lightoff within a few seconds. The improved mass transfer provides high conversion efficiency, allowing substantial reduction in converter volume, weight, and the amount of precious metal required. The close coupling of catalyst surface and inlet gas temperatures improves performance while lengthening catalyst life.

Fast lightoff technology is now incorporated to varying degrees in most American automobiles and other catalytic converter solutions, resulting in significant reduction in NO<sub>x</sub>, hydrocarbon, and CO emissions. The project also led to multiple follow-on breakthroughs and spinoff applications.

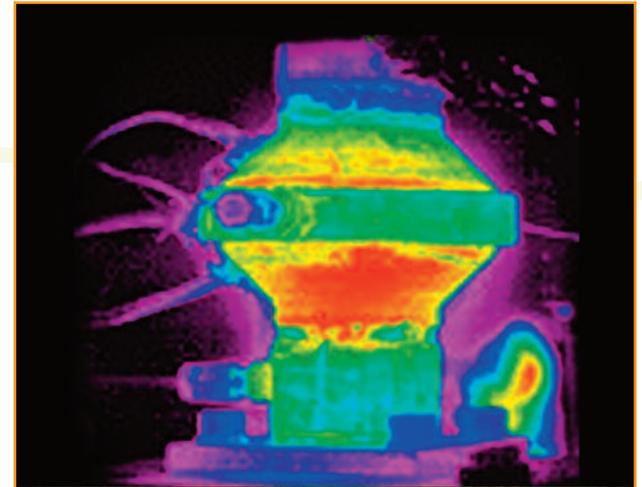
## Commercialization Information

Following initial Phase I and II support from the EPA's SBIR Program for fast lightoff catalytic converters, PCI received \$3.5 million in Phase III support from additional sources, including a direct EPA Phase III award for \$300,000 and funding from four automotive engine manufacturers and two automotive exhaust system manufacturers.

The technology also spun off to multiple follow-on applications now comprising most of PCI's annual revenues. PCI currently has 23 issued patents on the technology, with others pending. The first spinoff application was for specialty compact clean and efficient burners, including for anode gas burners for fuel cells and for infrared generators, producing some \$2.7 million in further development and an ongoing sales and license revenue business.

The company was awarded a National Science Foundation (NSF) SBIR Phase II grant for work on a

compact natural gas burner (with \$4.2 million more to date in Phase III revenues), and two Army SBIR Phase II grants for cleaner, more efficient liquid fuel combustion in Stirling and other reciprocating engines as well as for cookstoves (with \$4.4 million to date in Phase III revenues).



Microlith<sup>®</sup> Reactor prototypes and hot vibration operation



The technology also has been adapted successfully for use by liquid fuel reforming technology for fuel cells and other applications. PCI's Microlith® fuel-flexible fuel processor is ultra-compact, fast lightoff, highly efficient, and able to operate even with sulfur-containing JP8. For fuel cells, this offers fueling with conventional fuels, without needing a hydrogen infrastructure. PCI has received five additional SBIR Phase II grants for this work, with \$17.7 million to date in Phase III revenues.

### Company History and Awards

Founded in 1986, PCI develops advanced catalytic reactors and systems for energy sector applications, including clean and efficient combustion, fuel reforming, air cleaning, and chemicals manufacture. Partners include major industrial companies and the U.S government. The company has received multiple awards for its technology development, including the EPA's Environmental Technology Innovator Award in 1998, two Tibbetts awards for SBIR excellence, two Dawnbreaker Profiles in Success awards for commercialization achievement, two Army SBIR Achievement Awards, and eight SBIR success stories. PCI has 37 employees, working together to make the world a better place.

## SBIR Impact

- Catalytic reactors with clean and efficient combustion are needed to mitigate emission of air pollutants and CO<sub>2</sub>.
- PCI developed a Microlith® catalytic reactor that enables ultra-compact, high efficiency catalytic reactor solutions for a variety of clean energy applications.
- EPA's SBIR Program provided early support to what is now an expanding set of green energy solutions affecting multiple industries.
- Including follow-on applications, PCI's revenues from technologies developed with Phase III grant support exceed \$30 million to date.

