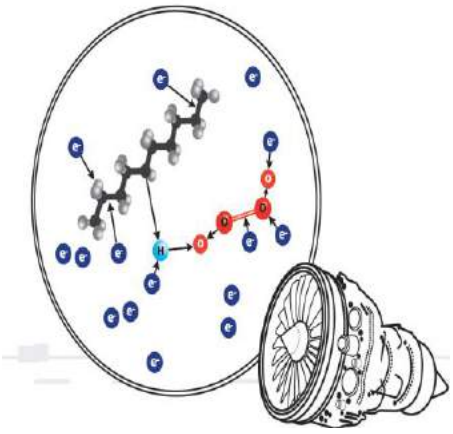
NASA continues to seek out innovation that provides unique solutions to difficult problems. NASA iTech was created to not only identify breakthrough technologies that address pressing issues here on Earth, but ones that also hold great promise in overcoming critical space-exploration challenges. All ingenuity is welcome, whether generated by business, academia and government organizations, or by any others who wish to make their leading-edge products and processes known to NASA leadership and agency partners in the private and public sectors.

FGC Plasma Solutions

Enhanced Fuel Injectors

Heat a source gas sufficiently, and the bonds that bind are broken: negatively charged electrons break free of the positively charged nuclei they orbit. Both then tumble about in the subsequent atomic mishmash. The result is plasma, the fourth state of matter. From this seemingly chaotic jumble, advantage may emerge. That's exactly what FGC Plasma Solutions is betting on.

Felipe Gomez del Campo is the company's chief executive officer. Not long ago, he was a high school student with a science fair project that became the genesis of his eponymous firm. Gomez del Campo believes FGC Plasma can integrate its plasma-assisted, combustion-topology approach directly and inexpensively into current combustor designs so that their fuel injectors that can be easily retrofitted within jet engines during routine maintenance.



Artist's conception of plasma-assisted combustion reactions promoted by FGC Plasma's technology. The company believes a plasma-assisted modified fuel injector could be inexpensively retrofitted within a jet engine during routine maintenance.

The innovation may lead to more efficient fuel use, especially at low power settings such as ground idle or decent. Fleet-wide adoption could eventually bring cleaner skies overall and longer-term operational savings for commercial aviation.

Reworking Fuel Injectors

Although plasma-assisted combustion is a well-known phenomenon that has been studied for more than 30 years, fine-tuning appropriate variants for specific commercial use has proved daunting.

All jet engines rely on compressors that raise the pressure of ingested air so that when the air is sprayed with fuel, combustion occurs. The ignited gas expands, exiting the engine via rear-mounted exhaust nozzles, turning the turbomachinery and propelling the aircraft forward.

FGC Plasma's solution to a more stable combustion is to rework the injector designs. Their approach increases flame stability even as the fuel-to-air ratio is decreased. Burning at lower fuel to air ratios allows for lower emissions as well as decreased fuel burn at low power settings.

Traditionally, the problem with this approach is that as fuel-to-air ratios decrease, combustion can become unstable. Plasma provides a solution here. Future, more fuel-efficient engine designs incorporating this technology from the design phase could offer further improvements.

Accelerating Commercialization

Although there may be substantial economic benefit from adoption of the modified injectors, airline-industry priorities and air worthiness requirements will result in a very long development path.

Given the stringent emissions requirements of power plants and the potential ability of FGC Plasma's technology to substantially reduce those same emissions, a nearer-term target will likely be gas turbines for power generation. Because the same manufacturers that develop jet engines also produce the turbines, manufacturers could work with FGC Plasma Solutions to further refine injector design, and demonstrate its effectiveness under real-world conditions.

First generation plasma-assisted injector from FGC Plasma Solutions undergoing testing at NASA Glenn Research Center

There, too, emissions reductions would be married to efficiency optimization. Plasma injectors would allow power-plant operators to set their equipment at much lower idle speeds, reducing thermal-cycling times, thus decreasing the normal wear and tear turbine engines routinely experience. Lower NOx emissions, a key regulated pollutant from this sector are also possible.

Less Carbon, More Savings

With the strong potential for rising airline-industry fuel costs in 2019. FGC Plasma estimates that widespread adoption of a plasma-assisted injector could cut industrywide fuel-burn expenses by up to five percent.

The new injector could allow U.S. commercial carriers to pocket as much as $600 million a year in savings, with a three percent overall increase in profitability, accompanied by a net atmospheric decrease annually of 20 million metric tons of carbon dioxide.

The company is beginning to explore applications in the defense industry, particularly notional designs of the specialized engines that would power hypersonic aircraft. Adoption of plasma-assisted injectors may enable lighter hypersonic engines and significant operational advantages.

Current Status

After initial work under a Space Act Agreement with NASA, FGC Plasma was awarded a NASA SBIR Phase I award to develop a plasma-based control system to enable clean, compact and low emissions combustor on future jet engines and is conducting its testing at NASA's Glenn Research Center. FGC Plasma's technical progress through their Phase I contract, combined with their recognition as the top "X-Factor" technology through NASA iTech's technology search, has enabled the startup to land a collaboration with a major engine manufacture for their Phase II proposal. FGC Plasma is also performing on SBIR contracts from DOE and DoD. FGC Plasma has operations at Argonne National Lab through DOE's Lab Embedded Entrepreneurship Program and at MIT.

More information available: ***FGC Plasma Solutions, 2018 NASA iTech Cycle I Forum presentation and NASA iTech***