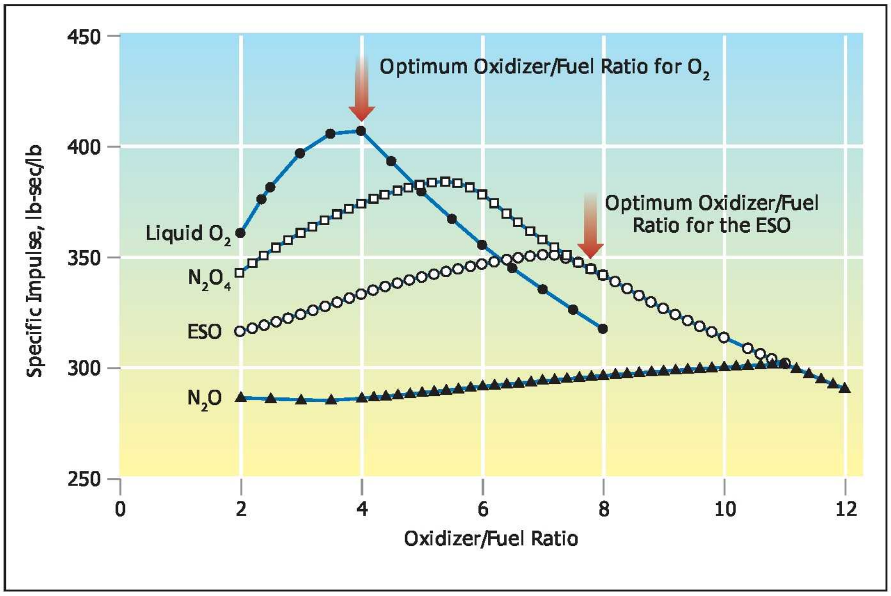

Specific Impulse Versus Oxidizer/Fuel Ratio was calculated for methane burned with either (1) N_2O_4, (2) an ESO comprising a mixture of 65 mole percent of N_2O with 35 mole percent of N_2O_4, (3) N_2O, or (4) liquid O_2. The combustion-chamber and exit pressures used in the calculations were 1,000 psi (≈6.89 MPa) and 0.05 psi (≈345 Pa), respectively. Stoichiometry favors higher oxidizer/fuel ratios for the ESO than for liquid O_2; this is fortuitous because, as the corresponding plots show, the higher mixture ratio yields higher specific impulse.

be useful in special terrestrial applications that could include ramjet and scramjet aircraft engines.

ESOs would offer an attractive alternative to liquid oxygen and other previously known oxidizer fluids, including the individual constituents of these mixtures:

- Unlike liquid oxygen and fluorine-based oxidizers, which must be stored under cryogenic conditions, ESOs could be stored at room temperature.
- In comparison with most previously known oxidizer fluids other than oxygen, nitrous oxide, and nitrogen peroxide, ESOs would be less toxic.
- In comparison with most previously known oxidizer fluids other than nitrous oxide, ESOs would be less corrosive, and would be more chemically stable in storage.

Calculations have shown that ESOs would offer high energy densities and that specific-impulse levels attainable by use of ESOs would approach those attainable by use of liquid oxygen with two hydrocarbon fuels — RP-1 (rocket propellant 1, which is similar to kerosene) and methane (see figure). ESOs would be hypergolic or nearly hypergolic with methane and RP-1 and with other fuels that include Jet-A (also similar to kerosene), hydrazine, and monomethyl hydrazine. A computational simulation has predicted that only benign exhaust products would result from burning methane or RP-1 with one of the ESOs (a mixture of 35 mole percent of N_2O_4 with 65 mole percent of N_2O): These exhaust products would be primarily CO_2, H_2O, and N_2, plus very small amounts of O_2.

This work was done by R. L. Sackheim of Marshall Space Flight Center and J. R. Herdy, Jr., of Qualis Corp.

This invention is owned by NASA, and a patent application has been filed. For further information, contact Sammy Nabors, MSFC Commercialization Assistance Lead, at sammy.a.nabors@nasa.gov. Refer to MFS-32407-1.

Planar Submillimeter-Wave Mixer Technology With Integrated Antenna

This technology can be used for terahertz radar imagers and in testing of quantum cascade lasers.

NASA's Jet Propulsion Laboratory, Pasadena, California

High-performance mixers at terahertz frequencies require good matching between the coupling circuits such as antennas and local oscillators and the diode embedding impedance. With the availability of amplifiers at submillimeter wavelengths and the need to have multi-pixel imagers and cameras, planar mixer architecture is required to have an integrated system. An integrated mixer with planar antenna provides a compact and optimized design at terahertz frequencies. Moreover, it leads to a planar architecture that enables efficient interconnect with submillimeter-wave amplifiers.

In this architecture, a planar slot antenna is designed on a thin gallium arsenide (GaAs) membrane in such a way that the beam on either side of the membrane is symmetric and has good beam profile with high coupling efficiency. A coplanar waveguide (CPW) coupled Schottky diode mixer is designed and integrated with the antenna. In this architecture, the local oscillator (LO) is coupled through one side of the antenna and the RF from the other side, without requiring any beamsplitters or diplexers. The intermediate frequency (IF) comes out on a 50-ohm CPW line at the edge of the mixer chip, which can be wire-bonded to external circuits. This unique terahertz mixer has an integrated single planar antenna for coupling both the radio frequency (RF) input and LO injection without any diplexer or beam-splitters. The design utilizes novel planar slot antenna architecture on a 3-μm-thick GaAs membrane.

This work is required to enable future multi-pixel terahertz receivers for astrophysics missions, and lightweight and compact receivers for planetary missions to the outer planets in our solar system. Also, this technology can be used in terahertz radar imaging applications as well as for testing of quantum cascade lasers (QCLs).

This work was done by Goutam Chattopadhyay, Imran Mehdi, John J Gill, Choonsup Lee, and Nuria Llombart of Caltech for NASA's Jet Propulsion Laboratory and Bertrand Thomas of Oak Ridge Associated Universities. Further information is contained in a TSP (see page 1). NPO-46880