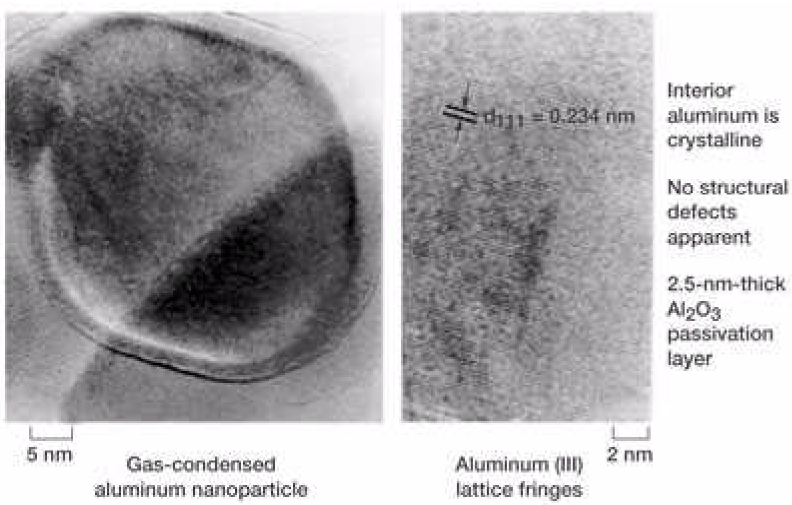
Nanotechnology Investigated for Future Gelled and Metallized Gelled Fuels

The objective of this research is to create combustion data for gelled and metallized gelled fuels using unique nanometer-sized gellant particles and/or nanometer-sized aluminum particles. Researchers at the NASA Glenn Research Center are formulating the fuels for both gas turbine and pulsed detonation engines. We intend to demonstrate metallized gelled fuel ignition characteristics for pulse detonation engines with JP/aluminum fuel and for gas turbine engines with gelled JP, propane, and methane fuel.

The fuels to be created are revolutionary as they will deliver the highest theoretically maximum performance of gelled and metallized gelled fuels. Past combustion work has used micrometer-sized particles, which have limited the combustion performance of gelled and metallized gelled fuels. The new fuel used nanometer-sized aluminum oxide particles, which reduce the losses due to mismatch in the gas and solid phases in the exhaust. Gelled fuels provide higher density, added safety, reduced fuel slosh, reduced leakage, and increased exhaust velocity. Altogether, these benefits reduce the overall size and mass of the vehicle, increasing its flexibility.



Typical aluminum nanoparticle created by Technanogy, Inc., with an aluminum vaporization process. The particles are from 20 to 100 nm in diameter. The interior aluminum is crystalline. No structural defects are apparent. There is a 2.5-nm-thick Al_2O_3 passivation layer. (Copyright Los Alamos National Laboratory; used with permission.)

Glenn obtained 75-lb of aluminum nanoparticles from Technanogy, Inc. (Irvine, CA) to create the new nanoengineered fuels. The preceding photomicrograph shows a typical particle created in Technanogy's aluminum vaporization process. The particle is surrounded by a 2- to 3-nm-thick coating of aluminum oxide, which prevents it from immediately igniting in air. The particles have diameters ranging from 20 to 100 nm.

Nanoengineered gellants were created by TRW (Redondo, Beach, CA). These nanogellants are similar to aerogels, are created with a supercritical drying process, and have surface areas ranging from 800 to 1000 m^2/g. These ultrahigh surface areas allow very little gellant to successfully gel the liquid fuel (less than 0.7 wt% for liquid hydrocarbons).

Nanoparticle gellants produced by TRW. The gellant is similar to an aerogel, has a fluffy powder consistency, and has a surface area of 900 m^2/g. (Copyright TRW; used with permission.)

The most critical part of the fuel development is the proper selection of the amount of gellant and the weight percentage of the aluminum particles. Glenn will formulate the final fuel. Precise processing of the nanoengineered aluminum particles is a key to the project's success. Critical to the best formulation and processing of these new fuels is the development of a new cryogenic viscometer by Glenn and Sierra Lobo (Milan, OH). This viscometer will allow the intimate and complete mixing of the nanometer gellants, the nanoparticles of aluminum, and the liquid fuels. A NASA building is being converted for the safe processing of the nanogellants and aluminum nanoparticles and for the safe mixing of these components with the liquid fuels.

Find out more about Small Business Innovation Research of fuels and space propellants http://sbir.grc.nasa.gov/launch/foctopsb.htm.

References

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