Progress in Advanced Propellant Research

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While alternative propulsion systems advance towards maturity, a reliance on traditional chemical propulsion remains. This continued use of chemical propulsion allows space-related industry and agencies to draw on existing assets, infrastructure, and experience with the established technologies in this area. Chemical propulsion can therefore be a less costly, more readily accessible propulsion option. Because of these advantages, research to push chemical propulsion systems to their theoretical limits is ongoing in parallel with development of other propulsion options. The mission of the Propulsion Directorate of the Air Force Research Laboratory is discovery and development of revolutionary and evolutionary improvements in several areas of chemical propulsion. This talk will cover new results in four propellant research programs. The ongoing AFOSR sponsored cryogenic solid High Energy Density Matter (HEDM) program has made progress towards the goal of trapping energetic species in solid hydrogen to create propellant with performance exceeding that of LOX/LH_2. Achievements include production of solid hydrogen in centimeter thick samples and generation of HEDM species for isolation in solid hydrogen. A DARPA funded program, which also receives AFOSR support, made a breakthrough with synthesis of the N_5^+ cation, the first all nitrogen species to be discovered in over 100 years. This cation could be the first step to a very high performance monopropellant composed entirely of nitrogen. Significant successes have also been recently made in a monopropellant development program targeted to replace hydrazine with much lower toxicity and higher performance propellants. Monopropellant formulations from this effort have predicted performance exceeding that of some bipropellant systems. Testing and characterization is underway. Finally, a collaboration with NASA/MSFC to synthesize and test high performance liquid hydrocarbon fuels has yielded several viable new candidates with both density and specific impulse higher than RP-1, the standard liquid fuel. These advanced chemical propellants will increase payload on existing vehicles and enable new designs for future vehicles.