Improved, Ecofriendly Solid Propellants for Space Related Applications

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Solid rocket fuels still produce large amounts of chlorine when burned, resulting in ozone depletion comparable to the effect of CFC's. The most recent project investigated the potential of cheaper and more ecofriendly solid propellants using ammonium nitrate instead of ammonium perchlorate as an oxidizer. The replacement decreases the burn rate below the critical limit by favoring the formation of a melting zone consisting of ammonium nitrate. In order to solve this problem, two approaches to burn rate acceleration were developed and tested. The first approach achieved its aims through the development of a copper chloride based complex catalyst, that relys on an enzymatic-like mechanism combining ionic and structural catalysis. The amine containing ligands were designed to interact with ammonium ions occuring within the melting zone. Synthesis of the ligands included chloroalkylation and was carried out in a new and more effective way by a catalytic addition reaction of an alkylamine and a halogenalkene. The purified catalyst was shown to decompose ammonium nitrate at more than twice the rate of the non-fitted complex prepared in the previous project, while also decreasing the minimal reaction temperature. The second approach designed and synthesized an energetic and thermolabile bonding agent enabling injection of the melting layer into the burning chamber. Beside several other preperative methods, cationic ring-opening polymerization of 1,2-diazetidines provided the best results. The oligomer introduces a new class of polymers consisting of alkylated, coupled hydrazine units, that are easier to handle and less toxic than the commonly used monomeric hydrazine derivatives.