ABSTRACT TO DOCTORAL DISSERTATION

Composite rocket propellants based on energetic polymers

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Composite rocket propellants are multicomponent systems consisting of a binder, which also serves as a fuel, an oxidizer, and various additives. Currently, the most commonly used binder is hydroxyl-terminated polybutadiene (HTPB), composed predominantly of carbon atoms and classified as a non-energetic polymer. An alternative to such materials is provided by energetic polymers, which contain functional groups rich in nitrogen and oxygen within their structure. The presence of these groups leads to an improved oxygen balance of the formulation, resulting in enhanced energetic performance of composite rocket propellants compared to systems based on non-energetic binders. At the same time, due to increasing environmental awareness, efforts are being made to reduce the use of ammonium perchlorate, the most commonly applied oxidizer in conventional composite propellant formulations, in favor of more environmentally friendly alternatives. It has been shown that the application of energetic polymers can compensate for the lower reactivity of alternative oxidizers, enabling the maintenance of high propellant performance.

The subject of this doctoral dissertation was to investigate the possibilities of modifying composite rocket propellants containing an energetic binder. The study focused on formulations based on glycidyl azide polymer (GAP) as the binder and ammonium nitrate as the oxidizer, taking into account current requirements aimed at eliminating chlorine-containing compounds while maintaining high performance characteristics of the propellants. Due to the use of a less reactive oxidizer compared to ammonium perchlorate, the dissertation also examined the impact of various metal fuels and catalytic additives on key performance parameters. In addition, the effect of structural modification through porosity was investigated, including both chemical foaming using a foaming agents and physical foaming based on a volatile solvent remaining after binder synthesis. The effectiveness of porosity introduction and its influence on propellant performance were evaluated. Furthermore, the potential of electrospraying

as a method for obtaining composite propellants with an increased interfacial contact area between formulation components was assessed.

The results obtained in this work confirm the effectiveness of the applied modification strategies and demonstrate that controlled tailoring of the formulation composition and structure enables improvement of thermal, kinetic, and performance parameters of composite rocket propellants based on ammonium nitrate and glycidyl azide polymer.