ADVANCED ALUMINUM POWDERS FOR SOLID PROPELLANTS

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Aluminum has been used in solid space propulsion for decades in the shape of micrometric metal powders thanks to its appealing energetic content (30 kJ/g). Typical mean sizes range from 5 to 50 microns. Its combustion is important for performance increment as well as for rocket combustion stability. However, agglomeration of aluminum particles occurs at the burning surface and condensed combustion products take part to nozzle expansion. The improvement of particle ignition and combustion properties are strictly correlated to the reduction of condensed combustion products, generated during combustion at the burning surface, which are source of performance losses[1] .

Literature data agree on the fact that metal particle combustion benefits from the reduction of particle size. Interesting results were obtained in the past when fuel powder size was reduced down to the nanometric range. In this respect, previous works in the literature demonstrate that agglomeration decreases whereas burning rate improves as particle size is progressively decreased [2,3]. However, this family of ingredients comes along with a number of issues correlated to their intrinsic size such as high compounding viscosity and low metal content. Activated micrometric metal powders try to be a compromise between standard micrometric and nanometric ingredients. In order to improve ignition and combustion properties of metal particles without decreasing the diameter in the submicrometric range, a specific activation process can be performed on standard metal powder fuels. Out of the different techniques documented in the open literature, particles can be activated by treating the external surface with reactants that weaken the external oxide layer [4].

The present paper aims at the comparison of standard micrometric activated and nanometric aluminum powders when used as fuels in a propellant. Ballistics and agglomeration of these advanced ingredients will be monitored when introduced in equivalent propellant formulations. Both total and partial replacement of standard metal fuel will be considered. This work wishes to describe in what extent activation process concurs to the improvement of propellant performance, in contrast to nanoaluminum.

References

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