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Altered Combustion Characteristics of Aluminum Fuels through Low-Level Fluoropolymer Inclusions with and without *in situ* Nanoaluminum

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ABSTRACT

Aluminum inclusions have been widely used to increase the specific impulse of solid rocket propellant. However, issues arise with the addition of aluminum in the form of agglomeration, which can cause kinetic and thermal losses (i.e., two-phase flow losses) through the nozzle, which can reduce motor performance by as much as 10%. Reduction of agglomerate size may reduce the effect of two-phase flow losses. Polytetrafluoroethylene (PTFE or Teflon^{TM}) inclusions into aluminum via mechanical activation (MA, milling) have been shown to produce a smaller coarse agglomerate size due to microexplosion of the composite particles at the propellant surface. Perflouroalkoxy (PFA) is a chemically similar to PTFE, and has yet to be investigated in metal combustion. Additionally, nanoscale aluminum (nAl) can be synthesized *in situ* within PFA. Using *in situ* nAl-PFA yields both a bottom-up and top-down approach when mechanically activated with aluminum, which may further modify the combustion properties. To support this prediction, PFA powders (with and without *in situ* nAl) were combined with aluminum via MA, systematically varying the Al/PFA mixture ratio (70/30 and 90/10 wt.% Al/PFA) and milling time (30 and 45 minutes). The resulting thermal behavior of the various milled powders was investigated via butane torch ignition and differential scanning calorimetry. The various MA Al/PFA powders appeared to burn well, comparable to equivalent MA Al/PTFE powders. However, the *in situ* nAl-PFA inclusions did not appear to have a significant effect on the combustion properties at these low heating rates. Future work should study these materials at higher heating rates (e.g., solid propellant, laser ignition) in order to fully elucidate the effect of *in situ* nAl-PFA.

KEYWORDS

Aluminum, nanoaluminum, PFA, mechanical actiation