METHOD FOR EFFECTIVE INCREASING THE RATE OF DECOMPOSITION OF AMMONIUM PERCHLORATE IN SOLID ROCKET FUEL

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The ability of ammonium perchlorate, a common oxidizer in composite solid rocket propellants, to rapidly decompose is very important for achieving high fuel performance. The higher the rate of thermal decomposition of ammonium perchlorate, the higher the fuel burning rate and, consequently, the jet thrust. In order to increase the rate of thermal decomposition of ammonium perchlorate, fuel, aluminum powder, is used in the form of microparticles, and recently in the form of nanoparticles, since they more effectively increase the rate of decomposition of ammonium perchlorate.

There are studies [1, 2] of the formation of aluminum nanoclusters as a result of the melting of aluminum nanoparticles and the rupture of the oxide shell on them due to the high internal pressure formed in the molten core of the nanoparticle. Due to the shock wave generated in the nanoparticle, many aluminum nanoclusters are sprayed into the fuel at high speed. We apply to aluminum nanoclusters the concepts we used in the hypothesis explaining the nature of catalysis on aluminum nanoparticles, and as a result we obtain a way to increase the rate of decomposition of ammonium perchlorate in solid rocket fuels.

According to our hypothesis, each aluminum nanocluster smaller than a certain size becomes a source of spontaneous electromagnetic radiation in the terahertz (THz) frequency range. And in the THz frequency range there are frequencies of vibrational and rotational oscillations in ammonium perchlorate molecules. Irradiation of the latter by THz photons emitted by aluminum nanoclusters excites oscillations in ammonium perchlorate molecules and promotes their decomposition.

Typically, the high catalytic activity of nanoparticles is explained by the high specific surface area of nanoparticles with decreasing nanoparticle size. We believe that in these processes the role of spontaneous THz irradiation of ammonium perchlorate molecules in contact with the surface of an aluminum nanocluster has not yet been taken into account.

We propose to increase the catalytic activity of aluminum nanoclusters in fuel (increase the rate of decomposition of ammonium perchlorate molecules, and ultimately increase jet thrust) by increasing the number of electrons that absorb longitudinal phonons in the nanocluster and then emit THz photons. This can be achieved by increasing the density of states of electrons near the Fermi level of aluminum by introducing into aluminum the impurity atoms of the so-called 3d-elements – atoms of the transition metals V, Cr, Mn and Fe.

REFERENCES

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