ON THE EFFECT OF MOLECULAR OXYGEN ON COMBUSTION OF ALUMINUM NANOPOWDER IN STEAM

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Abstract: The paper presents the results of numerical simulation of the combustion process of aluminum nanopowders in steam. The aim of the work was to study the effect of molecular oxygen formed during combustion on the dynamics of this process. The calculations have shown that the role of the reactions involving molecular oxygen is significant and they give a noticeable increase in the calculated rate of combustion of aluminum nanoparticles.

Keywords: combustion; aluminum; nanoparticles; steam; oxygen

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References

1. Franzoni, F., M. Milani, L. Montorsi, and V. Golovitchev. 2010. Combined hydrogen production and power generation from aluminum combustion with water: Analysis of the concept. *Int. J. Hydrogen Energ.* 35(4):1548–1559.
2. Zolotko, A. N., Ya. I. Vovchuk, N. I. Poletaev, A. V. Florko, and I. S. Altman. 1996. Synthesis of nanooxides in two-phase laminar flames. *Combust. Explo. Shock Waves* 32(3):262–269.
3. Peng, Q., X.-Y. Sun, J. C. Spagnola, G. K. Hyde, R. J. Spontak, and G. N. Parsons. 2007. Atomic layer deposition on electrospun polymer fibers as a direct route to Al_2O_3 microtubes with precise wall thickness control. *Nano Lett.* 7:719–722.
4. Yang, V., T. B. Brill, and W. Z. Ren, eds. 2000. *Solid propellant chemistry, combustion, and motor interior ballistics*. AIAA progress in aeronautics and astronautics ser. AIAA, Inc. Vol. 185. 990 p.
5. Dokhan, A., E. W. Price, J. M. Seitzman, and R. K. Sigman. 2002. The effects of bimodal aluminum with ultrafine aluminum on the burning rates of solid propellants. *P. Combust. Inst.* 29(2):2939–2946.
6. Ingenito, A., and C. Bruno. 2004. Using aluminum for space propulsion. *J. Propul. Power* 20(6):1056–1064.
7. Sundaram, D., V. Yang, and R. Yetter. 2017. Metal-based nanoenergetic materials: Synthesis, properties, and applications. *Prog. Energ. Combust.* 61:293–365.
8. Storozhev, V. B., and A. N. Yermakov. 2015. Combustion of nano-sized aluminum particles in steam: Numerical modeling. *Combust. Flame* 162(11):4129–4137.
9. Storozhev, V. B., and A. N. Yermakov. 2018. Effect of suboxides on dynamics of combustion of aluminum nanopowder in water vapor: Numerical estimate. *Combust. Flame* 190:103–111.
10. Julien, P., M. Soo, S. Goroshin, D. L. Frost, J. M. Bergthorson, N. Glumac, and F. Zhang. 2014. *J. Propul. Power* 30:1047–1054.

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