

Effect of Nano powders on the Laser Ignition

Abstract

The most energy-efficient way to increase the specific impulse and enhance the chamber's combustion characteristics is to use metal powder as a fuel in high-energy materials (HEMs). HEMs typically contain aluminum powders with varying distributions of particle size. Utilizing nonmetals, metals, or their oxides as catalysts is recommended in order to enhance the Al-based HEMs' ignition properties. The experimental results of the thermal decomposition and ignition of HEM samples made of ammonium perchlorate, butadiene rubber containing Alex aluminum nanopowders (NP), amorphous boron, iron, titanium, and copper are presented in this paper. When the HEM sample is ignited by a CO₂ laser at a heat flux density of 60–200 W/cm², Alex and additives containing 2 weight percent iron and copper NP reduce the ignition delay time by 11–16 percent. Due to the reduced temperatures of the onset and the intense decomposition of HEM under heating, they also increase the recoil force of the gasification products' outflow with the HEM surface by 1.3–1.5 times. The halfway substitution of Alex by a 5 wt% boron NP in the Stitch test lessens the start defer time by up to 20%.

Keywords: Nano powders • Laser ignition • Aluminum carbide

Introduction

Trunov et al. report as well as Gromov, the refractory layer on the burning surface, which contains the aluminum oxide particles and carbonaceous residues, has a significant impact on the aluminum oxidation that occurs during the combustion of composite solid propellants. Alumina has a significantly higher melting point than aluminum does. The ignition of aluminum particles is contingent on the high temperature inclination close to the consuming surface and the response layer of a high-energy material (Sew). The extensive exothermic oxidation is aided by the formation of cracks on the surface of the particle and the destruction of the oxide layer. Aluminum carbide is formed when Al reacts with carbon in the presence of silica to form aluminum carbide, which destroys the aluminum oxide layer on the surface of the particle.

Refs.'s findings from the research According to the primary function of metal nanopowder (NP) additives are merely to accelerate the thermal decomposition of oxidizer, nitramine, and combustible binder in the condensed phase of HEM during heating and combustion. In addition, the intermetallic compounds made of iron, copper, and titanium-or their oxides-react strongly with aluminum when heated. As a result, even though the ignition delay time remains the same, the plate surface temperature may decrease when these metal additives are added to a HEM sample.

Due to its high gravimetric and volumetric energy densities, boron is the additive that appears to have the greatest potential for use in solid propellants. However, the storage and combustion of a 23% inert oxide layer on the surface of boron particles significantly complicates its use. The oxide layer keeps an oxidizer out and increases the ignition and burning time of the particles. To improve the efficiency of boron powder combustion in composite solid propellants, a variety of processing methods and additives for metal powders and their oxides are utilized.

Boron can alter the characteristics of ignition and combustion in Al-based HEM and contribute to the agglomeration of aluminum nanoparticles on the burning surface of a composite solid propellant. Chintersingh and others point out that, in comparison to the initial micron boron

Stephanie Mikos*

Department of Material science Ethiopia

*Author for correspondence:

Stephanie_m5@gmail.com

Received: 03-Apr-2023, Manuscript No. aaamsr-23-96386; **Editor**

assigned: 05-Apr-2023, Pre-QC No. aaamsr-23-96386 (PQ); **Reviewed:** 19-Apr-2023, QC No. aaamsr-23-96386;

Revised: 21-Apr-2023, Manuscript No. aaamsr-23-96386 (R); **Published:** 28-Apr-2023; DOI: 10.37532/aaasmr.2023.6(2).22-24

particles that have a pure boron content of 95 percent, boron powder particles that have been washed in acetonitrile, toluene, and hexane have ignition delay times that are significantly shorter. The initial and modified powders' burning times and flame temperatures are nearly identical in this instance [1-5].

Discussion

Hashim et al. looked at how iron particles affected the combustion performance of B-HTPB-based solid fuels in their study. Note that a limited quantity of iron particles (~1 wt% of the complete mass of the example) fundamentally expands the consuming pace of B-HTPB. The burning time of a B-Fe composite is shorter than that of pure boron (which has a content of 95 percent by weight) when it oxidizes in an air-hydrogen stream and is ignited by a CO₂ laser. For this situation, the consuming rate increments with a lessening in the measurement of particles.

According to the TG/DSC analysis performed in, the presence of polyvinylidene fluoride (PVDF) results in an intensification of the oxidation that occurs on the surface of Al and B nanoparticles at an argon temperature of 700–800 °C. This is because PVDF releases additional heat and thins the Al₂O₃ and B₂O₃ oxide layer. In addition, the aluminum and boron particles react with the F ions produced by PVDF's decomposition. The B/PVDF/Al structure can be lighted in air with an Al Nano powder with a mass part of over 45 wt%. As the concentration of aluminum in the composition rises, so do the ignition delay time and burning time of B/PVDF/Al. At lower temperatures, the decomposition of PVDF is sparked by the oxide layer that is found on the surface of Al and B particles.

Cheng and others recommend utilizing a composite containing micron boron particles, Fe nanoparticles, and nitrocellulose (NC) for a more complete burning of boron particles in the Sew test in view of HTPB and AP. The addition of iron causes an increase in energy release and a decrease in the oxidation temperature of the boron and B/NC/Fe composite. When ignited by a CO₂ laser with pulse duration of 0.05 s, this additive reduces the B/N/Fe composite's ignition energy by 69% in comparison to that of the B/N composite. This effect may be caused by the iron additive's low ignition temperature. The added substance of the B/NC/Fe composite to a strong charge expands the consuming rate by 22% at pneumatic force of 0.1 MPa and the typical

compression rate in shut bomb by 45% at the greatest strain of ~ 3.0 MPa in examination with fuel containing the B/Nc composite.

Over the past forty years, global total energy consumption has increased by more than twofold. Industries are responsible for 6.1 Gt of global CO₂ emissions and consume 37% of the total final energy (IEA, 2018a). To lessen their negative effects on the environment, industrial plants must use renewable energy instead of fossil fuels. CO₂ emissions and production costs will decrease if industries are able to use renewable energy sources that are both cost-effective and sustainable.

The majority of industrial processes that operate below 200°C can currently benefit from solar energy as an alternative source. Within this range are 90% of the processes used in the paper, textile, and food industries. Significant cycles particularly appropriate for sun oriented energy double-dealing are washing, cooking, vanishing, purification, fading, drying, coloring, and giving heated water [6-9].

Conclusion

According to the US Energy Information Administration, these industries are regarded as the most energy-intensive. 52% of industrial heat demand is met by low (below 150°C) and medium (150-400°C) temperature processes, while the remaining portion is met by high temperature processes, according to the IEA's Renewable Energy for Industry Report. Solar heat use has the potential to save a lot of energy in industries with low to medium temperatures. Composite solid propellants with metal additives and micron-sized aluminum powder are difficult to ignite; they burn with incomplete condensed combustion products (CCP) and require more heat. As a result, the study's objective is to alter kinetic parameters, speed up chemical reactions, and shorten the ignition delay time while maintaining the same ignition conditions. The experimental results of the thermal analysis and ignition of Al-based HEM samples containing Nano powder additives are presented in this work: copper, iron, amorphous boron, and titanium.

References

1. Recasens M, Garcia S, Mackay E, *et al.* Experimental Study of Wellbore Integrity for CO₂ Geological Storage. *Energy Procedia*.114, 5249–5255 (2017).

2. Rahman AHA, Abdullah B, Dvn VO. Modelling of Carbon Dioxide Leakage in Abandon Wells Using Computational Fluid Dynamics. *Appl Mech Mater.* 625, 780–783 (2014).
3. Zhang M, Bachu S. Review of integrity of existing wells in relation to CO₂ geological storage: What do we know? *Int J Greenh Gas Control.* 5, 826–840 (2011)
4. Marangu JM, Thiong'o JK, Wachira JM. Review of Carbonation Resistance in Hydrated Cement Based Materials. *J Chem.* 2019, 8489671 (2011).
5. Teodoriu C, Kosinowski C, Amani M, *et al.* Wellbore integrity AND cement failure at hpht conditions. *Int J Eng Appl Sci.* 2, 2305–8269 (2013).
6. Conti C, Giorgini E, Landi L *et al.* Spectroscopic and mechanical properties of dental resin composites cured with different light sources. *J Mol Struct.* 744, 641–646 (2005).
7. Wei SH, Tang EL Composite Resins: A Review of the Types, Properties and Restoration Techniques. *Ann Dent.* 1, 28–33 (1991).
8. Hedzeleka W, Wachowiak R, Marcinkowska A *et al.* Infrared Spectroscopic Identification of Chosen Dental Materials and Natural Teeth. *Acta Phys Pol. A* 114, 471–484 (2008).
9. Gatin E, Ciucu C, Ciobanu G *et al.* Investigation and comparative survey of some dental restorative materials. *Opto-Electron Adv Mater Rapid Commun.* 2, 284–290 (2008).
10. Cramer N, Stansbury J, Bowman C. Recent Advances and Developments in Composite Dental Restorative Materials. *J Dent Res.* 90, 402–416 (2011).