Laser Ignition Characteristics of AP/HTPB Composite Solid Propellants Containing Metal Nanopowders

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Abstract: Ignition characteristics of Al micro-powders, Al nanopowders, Ti nanopowder and amine perchlorate(AP)/ hydroxyl-terminated polybutadiene(HTPB) composite solid propellants containing metal powders were studied by CO_2 laser ignition method with a wavelength of 10.6 μm at different heat fluxes, and the effects of Al size on ignition characteristics of Al powders and the effect of the different metal powders on ignition characteristics of AP/HTPB composite solid propellants containing metal powders were discussed under heat fluxes from 77.6 W·cm^{-2} to 365.1 W·cm^{-2}. Results show that the ignition delay times of Al powders gradually decrease with the increasing of heat fluxes. The ignition delay time is shorter and the ignition energy is lower ($t_{Jal\text{-}50}<t_{N\text{-}Al}<t_{Jal\text{-}150}<t_{Jal\text{-}200}<t_{5\mu m}$ and $E_{Jal\text{-}50}<E_{N\text{-}Al}<E_{Jal\text{-}150}<E_{Jal\text{-}200}<E_{5\mu m}$) when the size of Al powder is smaller. The ignition energy and delay time of Ti powder is smaller than the Al powder when their size is 150nm and their ignition process are obviously different. The ignition of AP/HTPB composite solid propellants containing metal powders appears on the surface of the sample first, and the order of the ignition delay time is $t_{RX\text{-}0}>t_{HT\text{-}5A}>t_{HT\text{-}1A}>t_{HT\text{-}4A}>t_{HT\text{-}3T}$ and the order of the ignition energy is $E_{RX\text{-}0}>E_{HT\text{-}5A}>E_{HT\text{-}1A}>E_{HT\text{-}4A}>E_{HT\text{-}3T}$, which is in accordance with the order of the ignition time of the corresponding metal powders($t_{5\mu m}>t_{Jal\text{-}200}>t_{N\text{-}Al}>t_{Jal\text{-}50}>t_{Ti\text{-}150}$).

Key words: ignition delay time; laser ignition; metal nanopowders; composite solid propellants

CLC number: TJ55; V512 **Document code**: A **DOI**: 10.11943/j.issn.1006-9941.2015.09.014

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