Inverse Identification of the Rate-dependent Micro Interface Parameters of HTPB/IPDI Composite Propellant

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Abstract: To study the change rule of mesoscopic interface performance of HTPB/IPDI (hydroxyl-terminated polybutadiene/isophorone diisocyanate) composite solid propellant with the loading rate, based on the molecular dynamics algorithm, the mesoscopic particles packing model of HTPB/IPDI composite solid propellant was generated. Bonding effect between particles and binder was modeled by a rate-dependent cohesive zone model constructed via combining viscoelastic standard mechanical units and exponential type rate-independent cohesion zone model(CZM). The relaxation parameters of the matrix material in the mesoscle finite element model were obtained through stress-relaxation tests of HTPB/IPDI curing films. The macroscopic mechanical response of HTPB/IPDI propellant at different loading rates of 0.1, 5 mm · min^{-1} and 20 mm · min^{-1} was simulated and calculated based on the model. The inversion analysis of rate-dependent cohesive zone model parameters was performed through Hooke-Jeeves optimization algorithm using numerical simulation results and the uniaxial tensile test results curve of of HTPB/IPDI propellant. The optimized values of interface parameters were obtained. The macroscopic mechanical behavior of HTPB/IPDI composite solid propellant at the loading rates of 50 mm · min^{-1} and 100 mm · min^{-1} was predicted using the established model. Results show that the predicted results are consistent with the actual experimental ones.

Key words: composite propellant; viscoelastic; meso-analysis model; cohesive zone model; interface mechanical property
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