Fused-ring Nitrogen-rich Heterocycles as Energetic Materials: Maintaining A Fine Balance Between Performance and Stability

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Abstract: Nitrogen-rich fused-ring energetic materials are a kind of energetic compounds with incorporating nitro and other energetic functional groups into the nitrogen-rich fused-ring heterocycle skeletons. Due to the excellent properties including high detonation properties, low sensitivity and high decomposition temperature, these nitrogen-rich fused-ring energetic materials have attracted wide research interest in the domestic and foreign scholars of energetic materials. The studies reveal that the stability of fused-ring skeleton has been significantly increased owing to the delocalization and resonance of π-electrons in nitrogen-rich fused-ring skeletons. For example, the detonation properties of 4-amino-3, 7-dinitrotriazolo-[5, 1-c][1, 2, 4]triazine 4-oxide (DPX-27) is comparable to RDX with detonation velocity and detonation pressure of 8.97 km·s^{-1} and 35.4 GPa, respectively. But its impact and fraction sensitivities are 10 J and 258 N, respectively, obviously lower than those of RDX. For 1,2,9,10-tetranitrodipyrazolo[1, 5-d: 5′, 1′-f][1, 2, 3, 4]-tetrazine(TNDPT), its detonation velocity and detonation pressure are separately 9.63 km·s^{-1} and 44.0 GPa, as high as those of CL-20. Moreover, its mechanical sensitivities (IS: 10 J, FS: 240 N) are obviously lower than CL-20. We can find that, as a new generation of energetic materials, nitrogen-rich fused-ring energetic materials can well balance the conflict between high stability and high detonation performance, showing great scientific and applied potentials. In this paper, the authors review the synthesis, detonation properties, stability and outlook of nitrogen-rich fused-ring energetic materials, which will provide some references for the subsequent study.

key words: nitrogen-rich; fused-ring; energetic material; stability; high-performance
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