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Synthesis of Advanced Energetic Materials[1]

REBECCA WILSON, None

For a given energetic material, performance is a combination of the rate of energy release and total energy content. Organic and metal-based energetics, respectively, represent the limiting cases, exhibiting strength in one area and weakness in the other. Many organic energetic materials readily detonate, but increasing total energy content using only known energetic functional groups is difficult. In contrast, combustion of aluminum metal can release more than three times the energy available from the same mass of organic explosive, but the rate of energy release is slow relative to detonation, and combustion is often incomplete. Current research in our department seeks to improve both the total energy content of organic explosives and the rate of combustion of aluminum-based materials. Novel arrangements of atoms within energetic molecules, along with new assembly methods for materials, are employed to improve both aspects of performance. In the case of organic energetic materials, novel functional groups can yield compounds with higher density, and therefore greater power, relative to conventional, nitro group-based materials. For aluminum-based materials, progressively smaller particles undergo more rapid and complete combustion. To prevent surface oxidation, one approach is to shield a core of low-valent aluminum atoms with a shell of ligands, while another is to develop aluminum-based fuels that are inherently air-stable. These methods will be discussed in the context of novel energetic materials synthesis.

[1]Research Department, NSWC IHEODTD