HYPERGOLIC FUELS

MOF over, hydrazine

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Hypergolic substances ignite spontaneously when exposed to an appropriate oxidizer, making them an integral component of the propellants used in spacecraft. At present, hydrazine and its derivatives are commonly used for this purpose, but they have the drawback of being highly toxic and carcinogenic. Now, Tomislav Friščić, Robin D. Rogers and colleagues — based at McGill University, the University of Birmingham and 525 Solutions, Inc. — design and synthesize zeolitic imidazolate frameworks (ZIFs) that have promising hypergolic properties and are free of carcinogenic components.

ZIFs are a subset of metal–organic frameworks (MOFs) in which nodes, formed of metal ions, are joined together by organic linker molecules based on imidazole, and are better known for their catalytic, gas storage and separation properties than their application as fuels. However, the researchers recognize the structural similarity between the imidazole linkers that make up ZIFs and the imidazolium cations found in energetic ionic liquids, which have alkyl groups connected to the imidazole moiety. Thus, they show that hypergolic behaviour can be brought about in ZIFs containing vinyl or acetylene groups. ZIFs based on zinc and cobalt — with acetylene-containing linkers — achieve ignition delays (an important parameter indicating the time between the oxidizer contacting the fuel and ignition) of 2 ms, which is well within the targets for hypergolic propellants. Moreover, the ZIFs are not sensitive to impact and are highly thermally stable in air. The tunability of MOF structures suggests that it should be possible to further tailor their hypergolic properties in the future.

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