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Exploiting the Tailorable Nanoporosity of Metal-Organic Frameworks for In-Situ Identification of Radioisotopes

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Radioactive xenon isotopes are signatures of clandestine underground nuclear tests. Their low concentrations remote from the event require collection and separation from large quantities of air using porous carbon sorbents. Unfortunately, due to their short half-lives, large dilution factors, and the long times required to remotely acquire samples, information concerning the time, location, abundance of specific isotopes produced in the event can be lost. Consequently, detection strategies are needed that enable much more rapid isotope identification. We will describe in-situ radioisotope identification by beta-gamma coincidence in a portable system enabled by Metal-Organic Frameworks (MOFs), a new, highly tailorable class of sorbents with surface areas as high as 7000 m2/g. MOFs possess a combination of properties unique among nanoporous materials. First, their ultrahigh surface areas facilitate selective adsorption of weakly interacting gases such as xenon. Second, established structure-function relationships governing MOF gas uptake enable rational design of materials optimized for specific applications (e.g., to selectively adsorb Xe). We demonstrate that MOFs enable the identification of radioactive xenon isotopes virtually in real time when used in a novel high-pressure detection system we designed. Our MOF-enabled detection concept could dramatically improve the reliability, timeliness, and information content of systems used for CTBT verification.

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