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Colorimetric Detection of Water Vapor Using Metal-Organic Framework Composites

Purpose: Water vapor trapped in encapsulation materials or enclosed volumes leads to corrosion issues for critical NW components. Sandia National Laboratories has created a new diagnostic to indicate the presence of water in weapon systems.
Impact: Component exposure to water now can be determined instantly, without need for costly, time-consuming analytical methods.

Water vapor trapped in encapsulation materials or enclosed volumes that have lost their hermetic seal may lead to corrosion of critical NW components. Although electronic sensors can provide real-time information and high sensitivity, a power-free method capable of bracketing the water vapor content within the weapon environment is preferred. To that end, by combining nanoparticles of nanoporous Metal-Organic Framework (MOF) with water-permeable organic polymers, Sandia scientists have developed a colorimetric detection material that enables a rapid, quantitative, and easy to interpret indication of the presence of water in weapon systems. Composite films of these turn from dark purple to blue or turquoise when exposed to water (vapor or liquid). By combining films with different water permeability, a color scale can be created that indicates either time of exposure to water or relative humidity. With this new diagnostic, component exposure to water now can be determined instantly, without need for costly, time-consuming analytical methods. This will reduce the time required to determine root cause of corrosion-induced component failures that may occur due to the presence of water.

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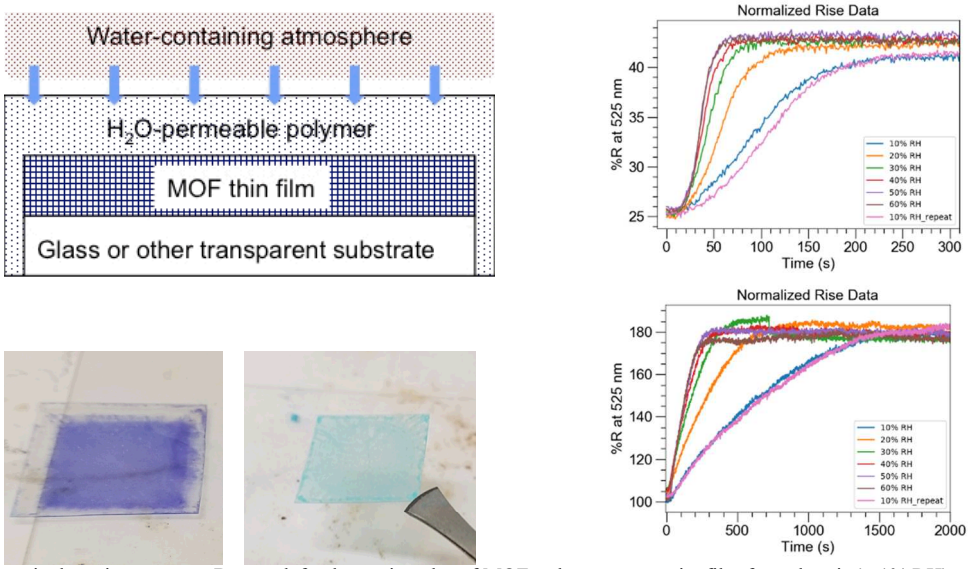

Top left: Colorimetric detection concept. Bottom left: change in color of MOF-polymer composite film from dry air (< 1% RH) to room air (~20% RH). Right: plots of reflected light intensity at 525 nm as a function of time and RH. Thin polystyrene coating (< 1 µm), top, and thick polystyrene coating (17 µm), bottom. Note the 10-fold difference in time to color saturation between the samples.