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CASE STUDY

Colour Changing MOFs for Visual Detection

The Challenge

Metal–organic frameworks (MOFs) are essentially molecular sponges that capture and release smaller molecules, such as CO_2, making them a hot topic in the molecular separation and storage space. The issue is, that by eye, it is impossible to tell if a MOF has captured something. So how can you tell if they're 'working'? Short answer is that you can't, unless you have analytical equipment, or a MOF that changes colour when it captures or releases guest molecules.

Hua and co-workers from the **University of Melbourne** have developed just that: reversible colour changing MOFs, specifically lanthanoid (Ln)-containing MOFs that change colour when exposed to UV radiation, i.e photoswitches. The chemistry behind this change was thought to be due to the Ln redox activity as the colour switching speed correlated with the accessibility of certain oxidation states in the Ln. For example, the Eu(III) MOF switches colour fastest—consistent with the accessible Eu(II) state—while the Ce(III) analogue is the slowest, likely because Ce(II) is hard to access. Determining whether this correlation was causation became the key science question as the answer is the key to optimising the MOFs colour change to various applications.

The Solution

Use the **MEX-1 Beamline** to check if the Ln oxidation states in the MOFs actually change.

MEX-1 X-ray absorption spectroscopy allowed us to compare the oxidation states of the Lns in the MOFs before and after UV-induced colour change. Interestingly--though less exciting of a result--is that we saw no Ln oxidation state change in any of the MOFs, indicating that a different mechanism is responsible for the colour change.

The Impact

Our result is important because it provides insight into the photoswitching mechanism, the decipherment of which provides the researchers with the insight they need to tailor their MOF to change colour when binding and releasing guest molecules, not just in the presence of UV. Optimising MOFs in this way is key to integrating them into green or wider technologies everyday people can use and understand, for example "at home" CO_2 capture, i.e. sensing by colour change.

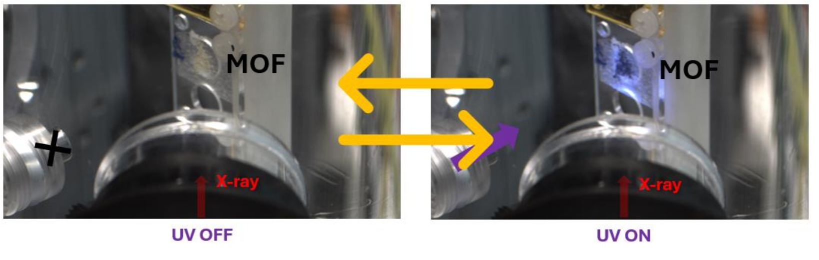

Figure 1. Experimental setup at the MEX-1 Beamline and MOF colour change: Sample endstation fit with a port that supports a liquid light guide connected to a 365 nm LED source. Before UV exposure, the MOF appears white. With UV exposure, the MOF turns dark blue. Once the UV is gone, the MOF reverts to being white in colour.

Research Priority

Molecular separation and storage

ANSTO capability/instrument

Medium Energy X-ray Absorption Spectroscopy – 1 (MEX-1)
ANSTO Australian Synchrotron

Collaborators/Client

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UN Sustainable Development Goals

13. Climate Action

13 CLIMATE ACTION

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