Fabrication of free-standing ultrathin films of porous metal-organic frameworks by liquid-phase epitaxy and subsequent delamination

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Metal-organic frameworks (MOFs) are highly ordered, crystalline new porous materials, that are composed of inorganic precursors and organic linker molecules to form one, two or three dimensional structures.

**MOF applications:**
- Hydrogen storage
- Methane storage
- Gas separation
- Catalysis

**Liquid-phase epitaxy (LPE) method**

The LPE technique is a new method used grow multifunctional MOF thin films (SURMOFS) on functionalized substrates. SURMOFs grown are very homogeneous, well crystalline and highly oriented.

**Characterization of SURMOFs**

XRD clearly showed the MOF thin films are highly crystalline and perfectly oriented. SEM and AFM demonstrate that the growth is controlled, selective and homogenous on functionalized surface.

**Delamination process of SURMOFs**

Aim of delamination:
- Application in different fields such catalysis, fabrication of membranes for gas separation, biology, etc..
- The method employs a lift-off process using PMMA

**Characterization of delaminated SURMOFs**

The TEM, SEM and optical microscope technique have been used to investigate of delaminated MOF thin films. The sample shows no evidence of fracture, deformation of delaminated samples. SAED pattern showed the MOF films remain as crystal.

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**Figure 1:** Structure of HKUST-1 [Cu3BTC2(H2O)n]

**Figure 2:** LPE method for the growth of SURMOFs (surface anchored MOF) on the functionalized organic surface (SAM) by repeated immersion cycles, first in solution of metal precursor and subsequently in solution of organic ligand.

**Figure 3:** X-ray diffraction pattern of HKUST-1 on different functionalized organic surface (SAM).

**Figure 4:** SEM image of HKUST-1 squares grown on a SAM laterally patterned by µCP on a gold substrate.

**Figure 5:** Schematic presentation for the delamination process of selectively grown MOF thin films by PMMA-shaving technique methods.

**Figure 6:** optical microscopy, SEM images and SAED pattern of delaminated samples. The delaminated HKUST-1 squares on TEM-Grid by PMMA-shaving methods.