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

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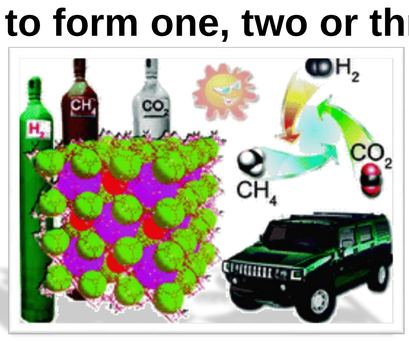
Metal-organic frameworks (MOFs)

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**



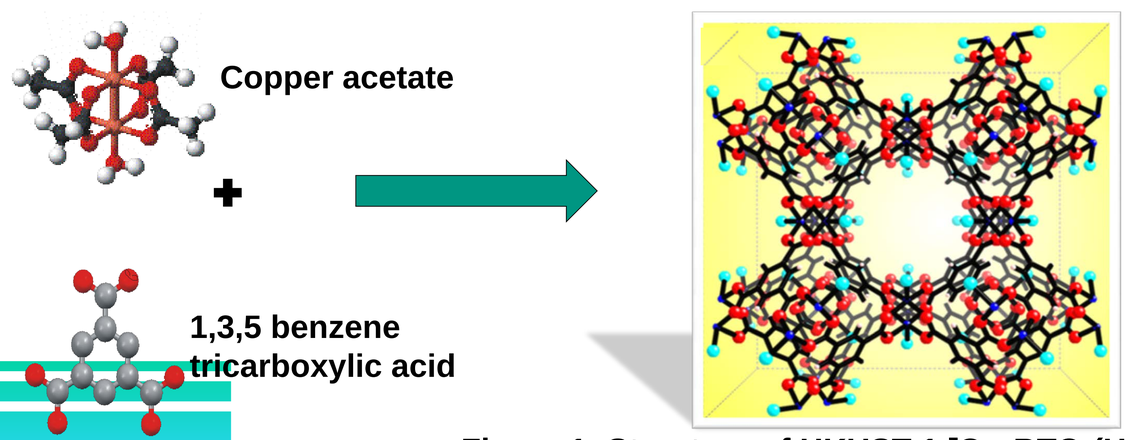


Figure 1: Structure of HKUST-1 [$Cu_3BTC_2(H_2O)_n$]

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

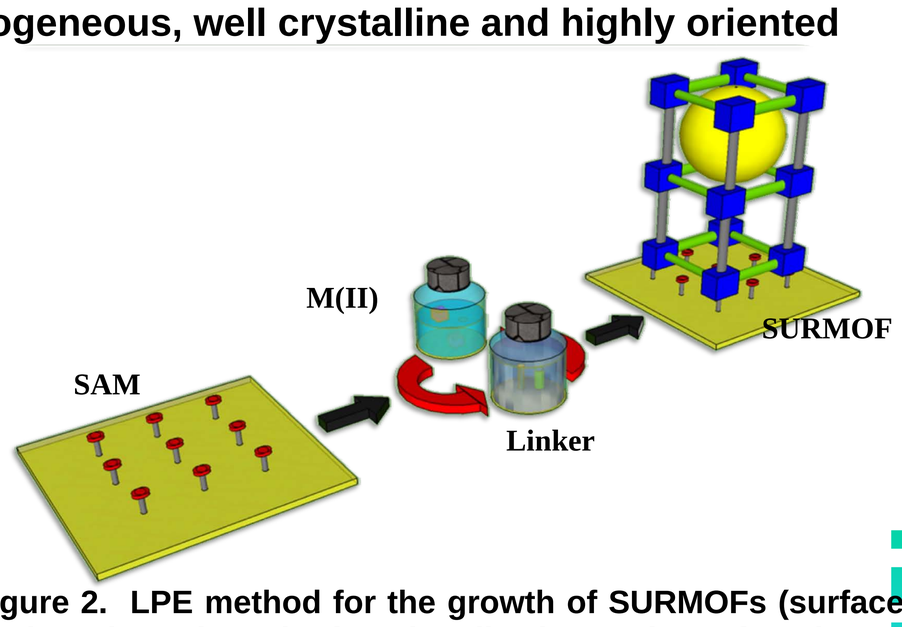


Figure 2. LPE method for the growth of SURMOFs (surface anchored MOF) on the functionalized organic surface (SAM) by repeated immersion cycles, first in solution of metal precursor and subsequently in solution of organic ligand.

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.

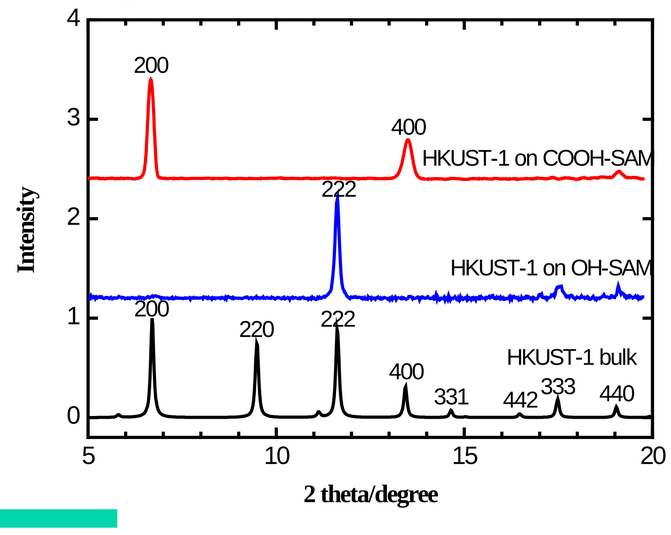


Figure 3: X-ray diffraction pattern of HKUST-1 on different functionalized organic surface (SAM).

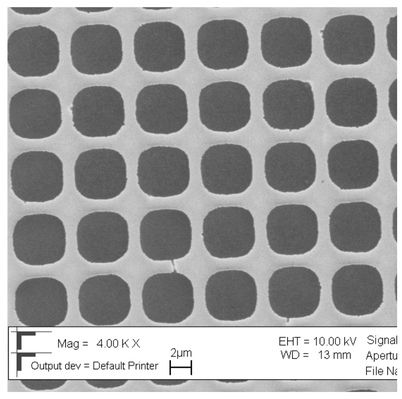


Figure 4: SEM image of HKUST-1 squares grown on a SAM laterally patterned by µCP on a gold substrate.

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

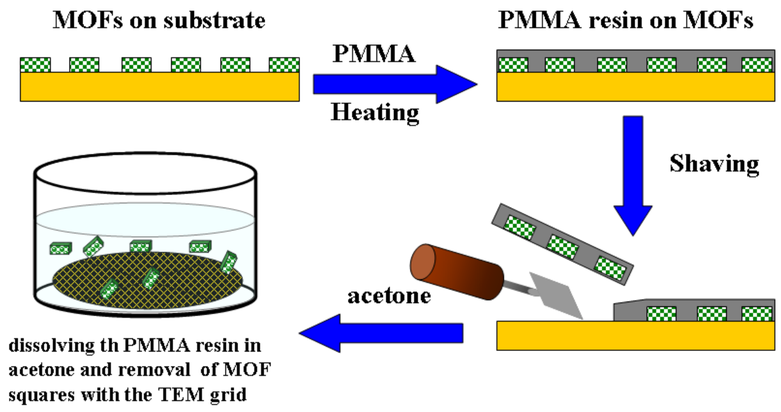


Figure 5: Schematic presentation for the delamination process of selectively grown MOF thin films by PMMA-shaving technique methods.

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.

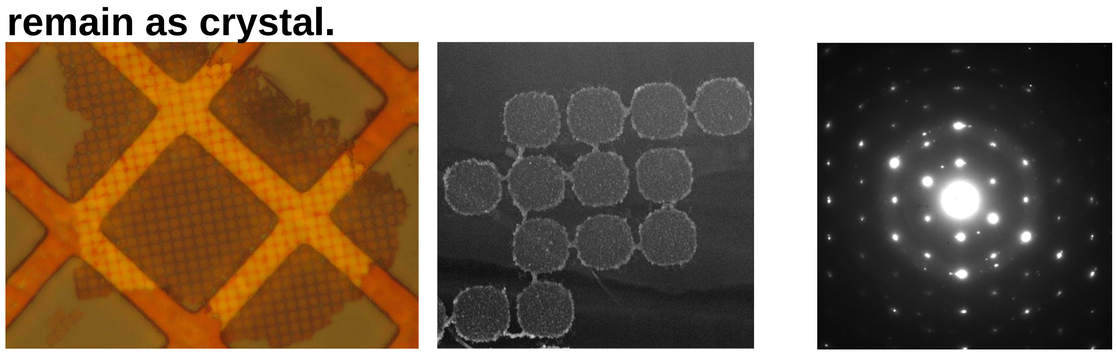


Figure 6: optical microscopy, SEM images and SAED pattern of delaminated samples. The delaminated HKUST-1 squares on TEM-Grid by PMMA-shaving methods.

M. Darbandi, H. K. Arslan, O. Shekhah, A. Bashir, A. Birkner, Ch. Wöll, Physica Status Solidi-Rapid Research Letters 2010, 4, 197.