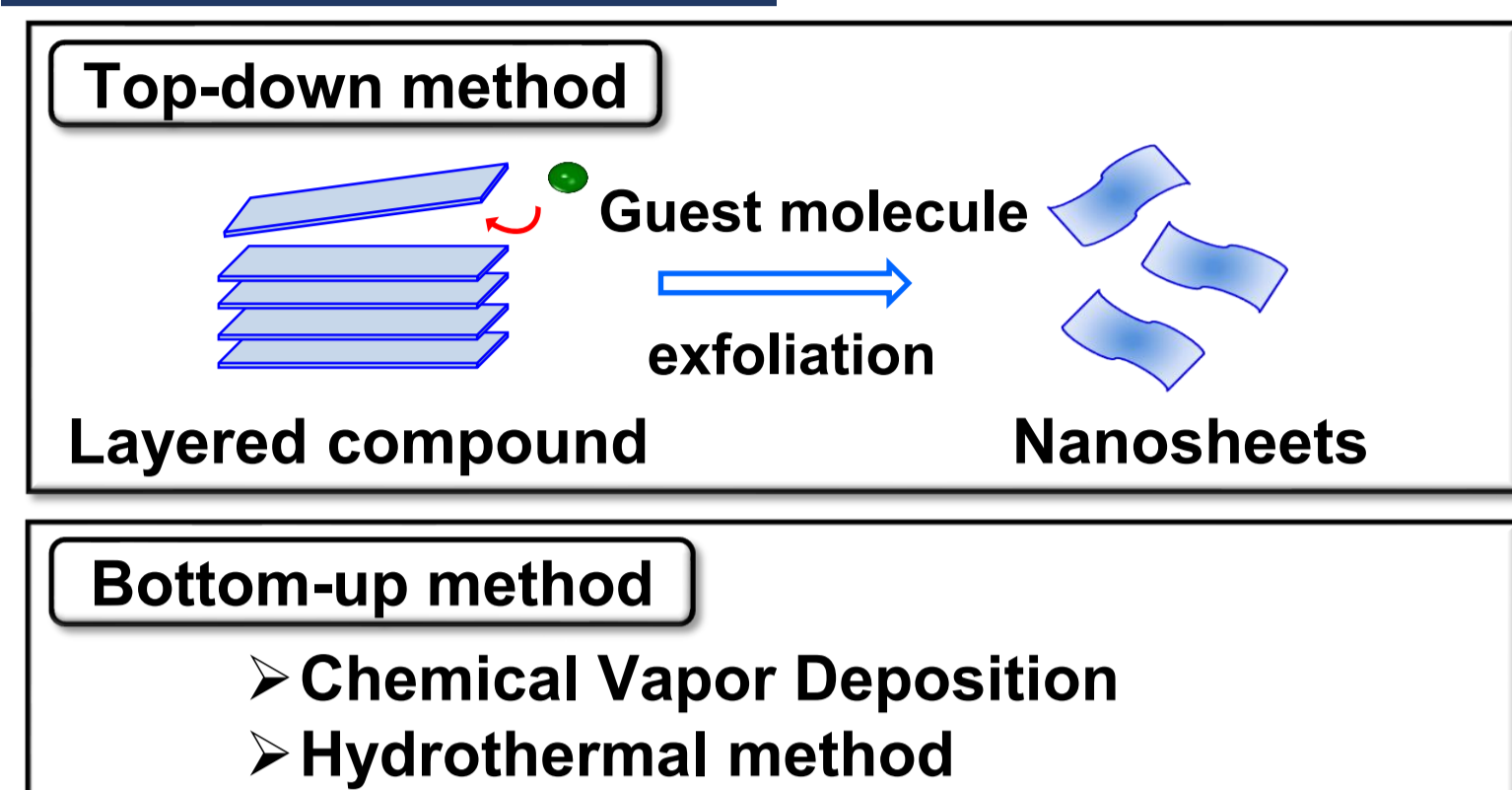


# Simple “Nanosheets” synthesis

## New method to synthesize thin “Nanosheets” for various materials

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### 1. Background Conventional Method to synthesize “Nanosheets”



#### (Disadvantages and Limitations)

- Applicable materials are limited.
- Large energy is required.
- Not suitable for tens of nanometer sheets production
- Large-scale equipment is required.

**“New Simple Method”**  
has been strongly awaited  
The method can;

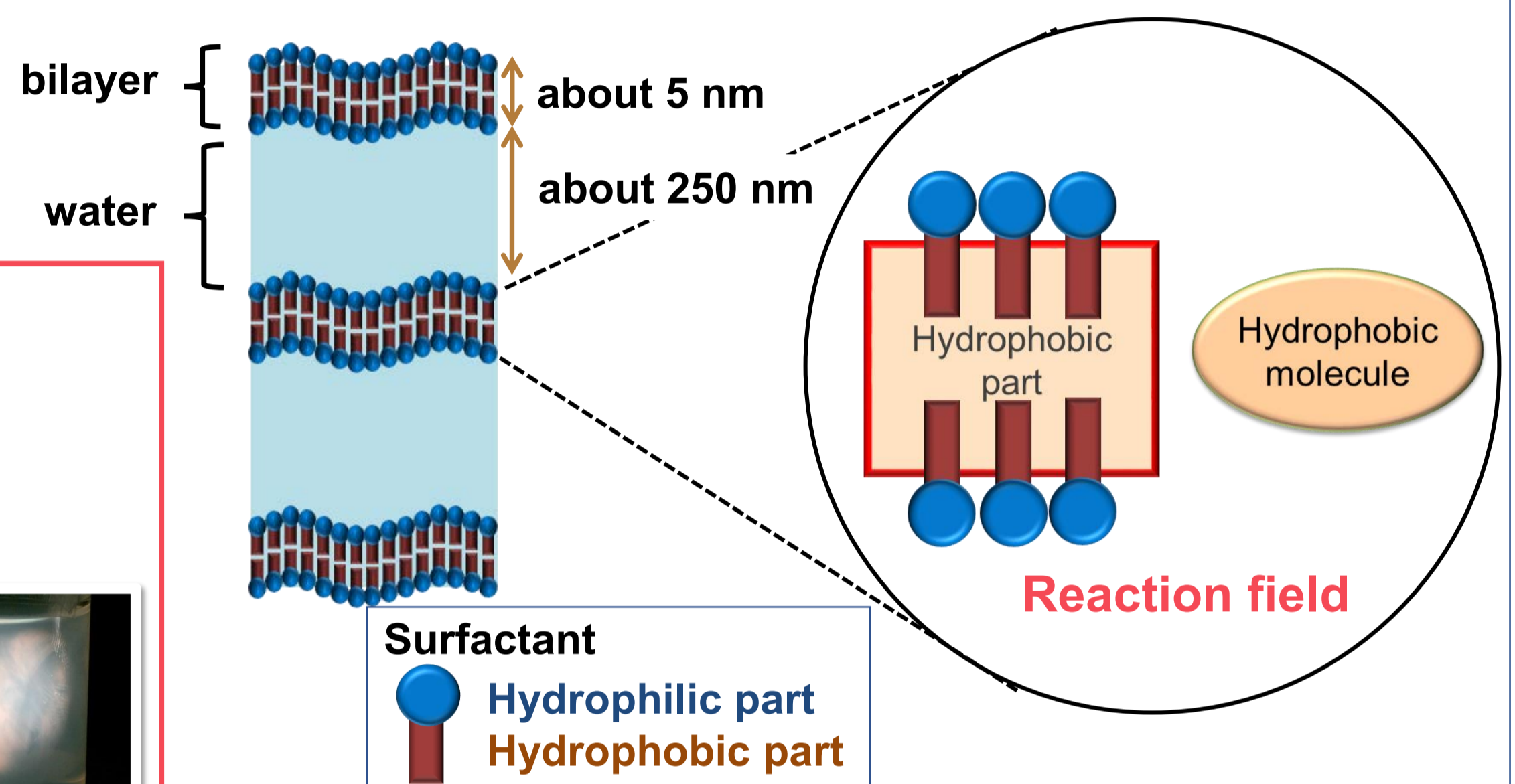
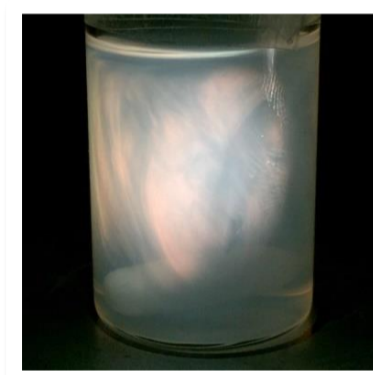
- be applied to various materials
- realize very thin (less than 10nm) nanosheets

### 2. Principle of the Invention

We developed and invented “New Simple Method”, which use “**Hyperswollen Lamellar Phase (HL phase)**” for synthesis of the very thin nanosheets.

HL phase has bilayers highly-separated (ex. ~200nm) by solvent.

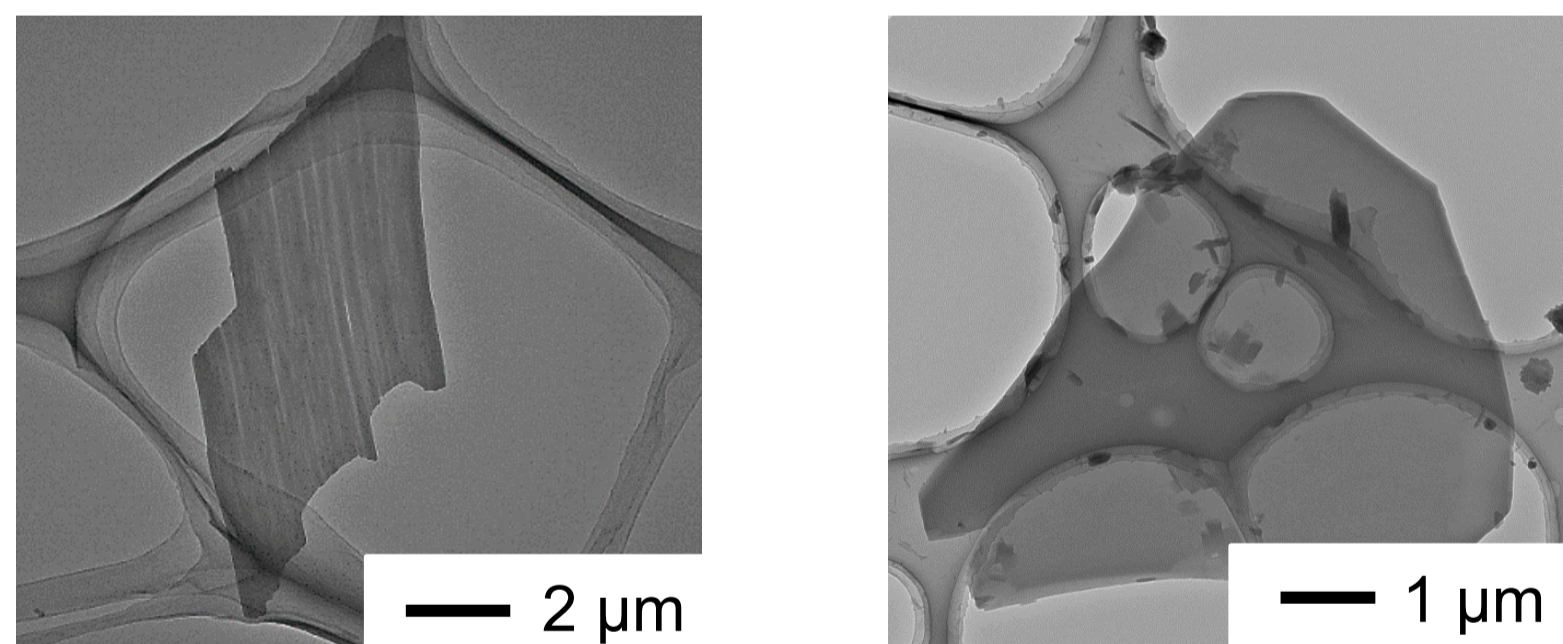
- The materials for forming nanosheets, the solvent (H<sub>2</sub>O and/or organic solvent) and the surfactant will be mixed together.
- The HL phase will be formed after being heated and stirred.
- When the HL phase is suitably formed, an iridescent color due to the Bragg reflection of visible light can be observed.



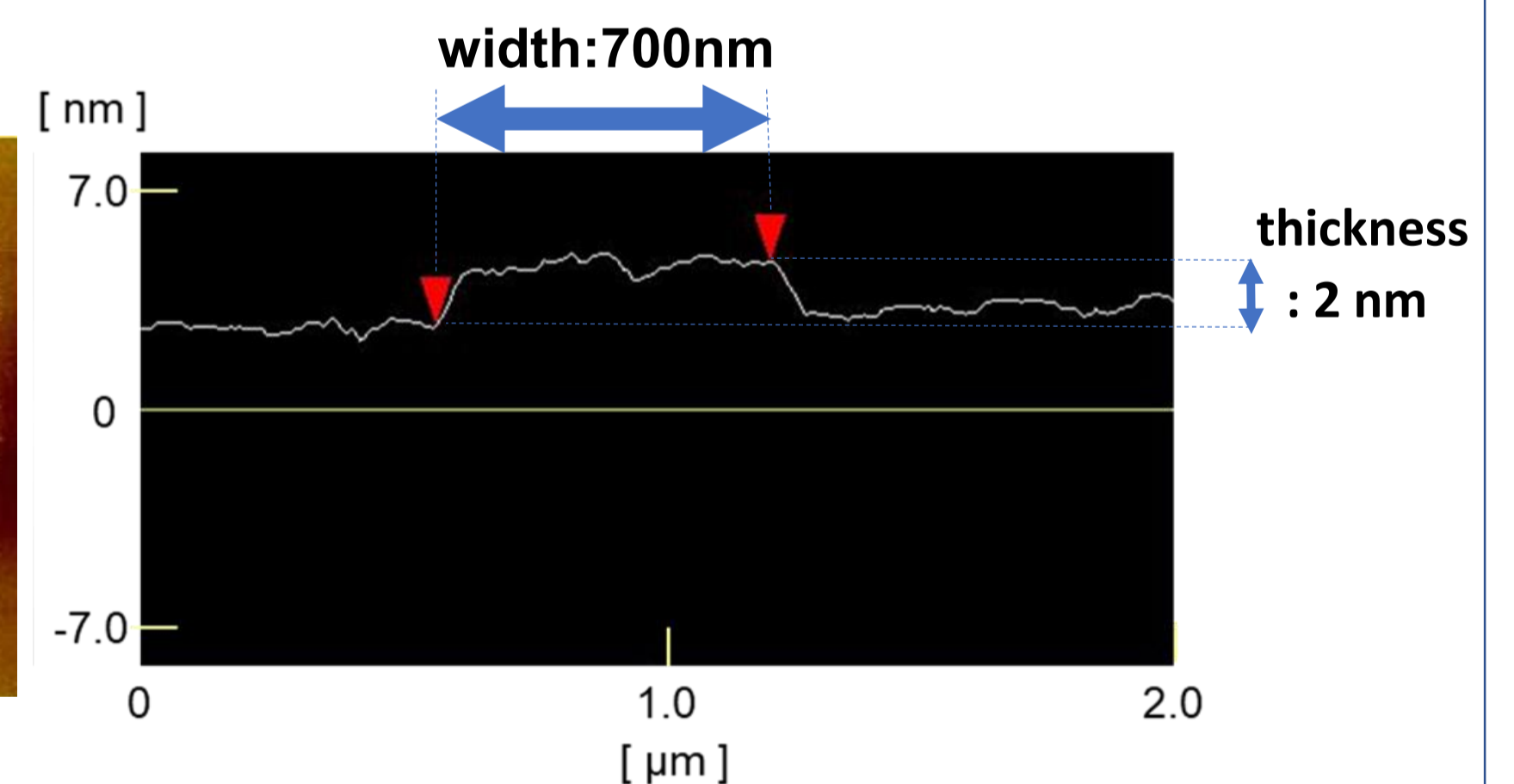
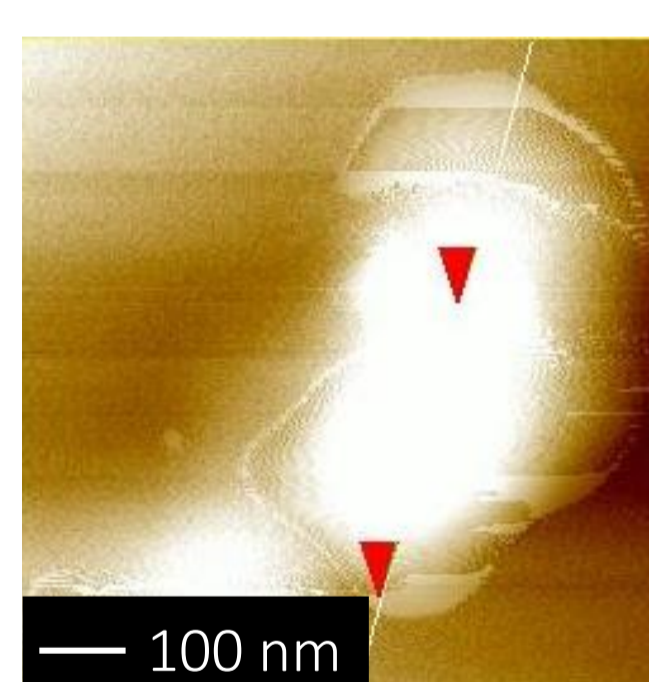
### 3. Experiment and Result

Nanosheets example: Metal Organic Framework (MOF)

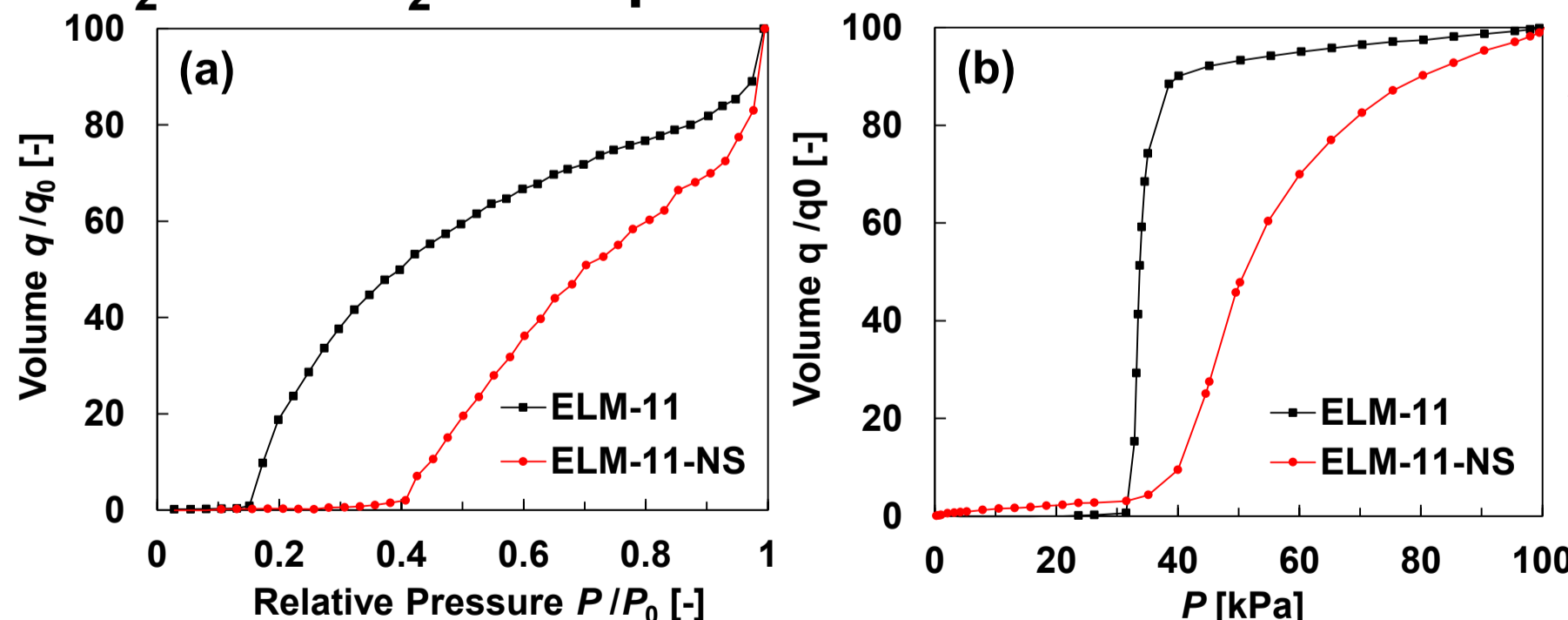
#### ◆ TEM



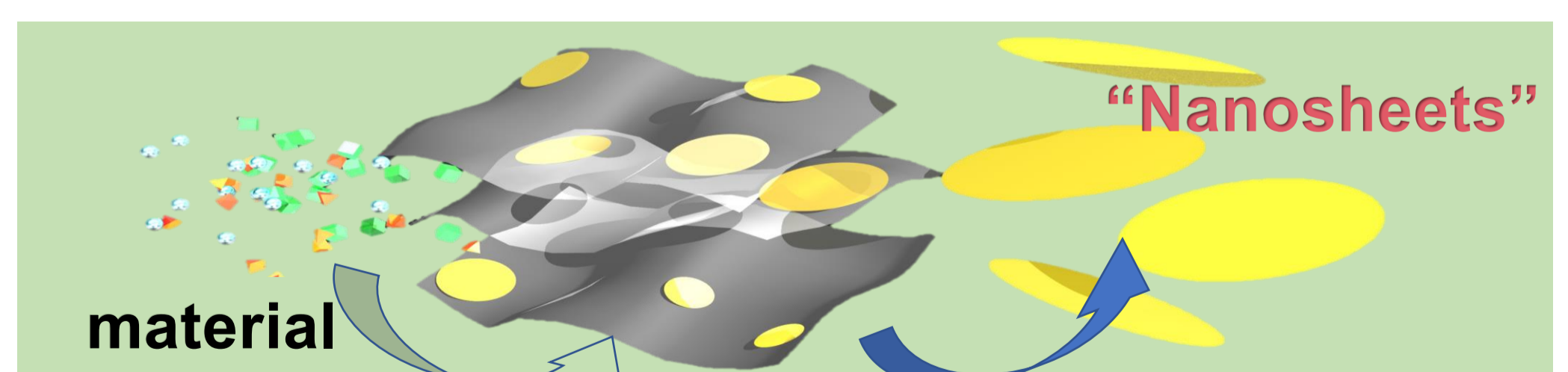
#### ◆ AFM



#### ◆ N<sub>2</sub> and CO<sub>2</sub> adsorption



◀ (a) when increasing the relative pressure of N<sub>2</sub> at 77 K and (b) when increasing the absolute pressure of CO<sub>2</sub> at 273 K adsorption isotherms of bulk sample and Nanosheets of MOF (ELM-11)  
※ELM-11 : [Cu (bpy)<sub>2</sub>(BF<sub>4</sub>)<sub>2</sub>]



The MOF nanosheets can be obtained by large gate-opening pressure.

### 4. Application Examples

- Porous material
- Adsorbent
- Catalyst
- Surface modification material etc.

### 5. Patent Licensing Available

Patent No.: WO2018/016650 (JP, US)  
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