Material

Room-Temperature Dry Etching of Metal-Organic Frameworks

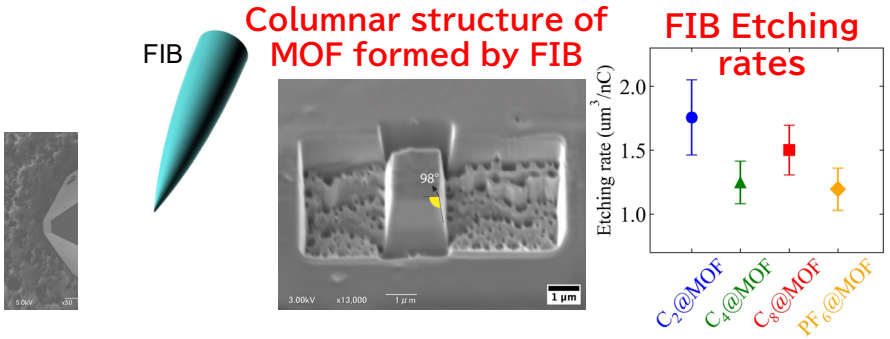
Kentaro Kinoshita
Professor, Department of Applied Physics, Tokyo University of Science

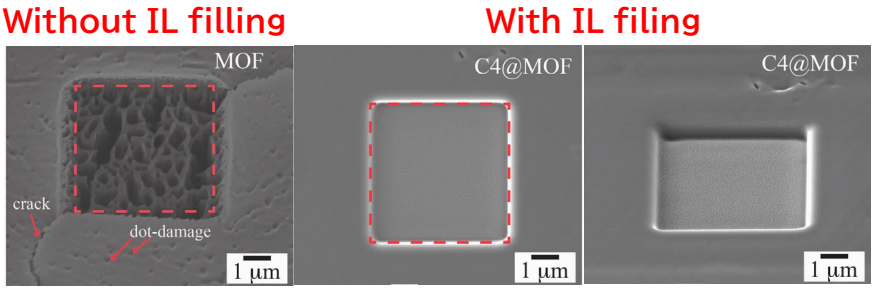
Purpose of Research

Metal-Organic Frameworks (MOFs) are expected to have a wide range of applications such as gas adsorption and storage, molecular-selective filtering, and catalysis, due to their high specific surface area and highly tunable structures. However, etching techniques, particularly dry etching (physical etching) of MOFs have not reached a practical level. Conventional methods require cooling to avoid damage. The aim of this study is to enable dry etching of MOFs at room temperature by introducing ionic liquids (ILs) into the MOF pores, thereby establishing a microfabrication technique for MOFs.

Summary of Research

We have previously demonstrated that filling the pores of MOFs with ILs can simultaneously overcome two major challenges in MOF applications: moisture-induced degradation and crystal fragility. It has also become clear that IL-filled MOFs (IL@MOFs) exhibit excellent dry etching (FIB: Focused Ion Beam Etching) resistance.





Points

- Room-temperature dry etching of MOFs is now possible.
- Microelectronic devices that leverage unique properties of MOFs can be realized.

Future Developments

2026.3 Elucidation of damage introduced into MOFs by dry etching
2026.9 Demonstration of IL@MOF-based micro gas sensing device
2027.3 Establishing guidelines for controlling the physical properties and functionalities of IL@MOFs.

Comparison with Conventional or Competitive Technologies

- Cooling was conventionally required.
- This approach made fine patterning via dry etching possible by filling MOFs with ILs.

Expected Applications

Our technology enables the integration of MOFs, which have excellent adsorption /desorption properties and molecular selectivity, into semiconductor processes.

Challenges in Implementation

We will collect detailed data on dry etching-induced damage and investigate its correlation with the physical properties and functionalities of IL@MOFs.

What We Expect from Companies

This technology offers a groundbreaking advantage by enabling dry etching of MOFs at room temperature. Furthermore, once the interactions between ILs and MOFs are clarified, it will be possible to further enhance the physical properties and functionalities compared to MOFs alone, or even impart new functions, paving the way for innovative electronic devices. We welcome collaborative research opportunities with companies interested in this field.

■ Intellectual Property:
JP Appl. 2024-186805
■ Sample: Yes

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TOKYO UNIVERSITY OF SCIENCE Organization for Innovation and Social Collaboration
1-3, Kagurazaka, Shinjuku-ku, Tokyo, 162-8601, Japan E-MAIL: ura@admin.tus.ac.jp