Soft Porous Crystals: Expanding the Paradigm of MOF Chemistry

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For decades, functional materials have been designed under a central principle: rigidity defines performance. Dense and stable structures have been associated with key properties such as conductivity, magnetism, and mechanical strength, while structural flexibility has generally been regarded as a weakness. The emergence of metal–organic frameworks (MOFs) introduced the first paradigm shift by demonstrating that **precisely designed porous networks can be constructed at the molecular level**, establishing a platform for controlling space in crystalline materials. Building on this foundation, a second conceptual advance has emerged: **softness and structural dynamics can themselves generate function**. This lecture focuses on Soft Porous Crystals (SPCs),[1] which undergo reversible, stimulus-responsive structural transformations upon interaction with guest molecules. Unlike conventional porous materials with static architectures, SPCs exhibit dynamic behaviors, such as breathing and gate opening. In these systems, function is not solely defined by static structure, but arises from the interplay between flexibility and molecular recognition, enabling selective adsorption and responsive transport. These findings demonstrate that **crystalline order and structural softness can coexist**, challenging the traditional view of materials design. Recent advances further extend MOF chemistry toward hybrid systems,[2] where interface engineering enables the translation of dynamic molecular behavior into macroscopic functionality. This expanding paradigm—from designed frameworks to adaptive systems—opens new directions for addressing challenges in energy, environment, and beyond. It also suggests a broader shift in materials chemistry,[3] where **function emerges not only from structure, but from its ability to respond and adapt**.

1. S.Horike, S.Shimomura, S.Kitagawa, *Nature Chem.* **2009**,1,695-704.
2. S.Kitagawa, *Acc.Chem.Res.,* **2017**,50,514-516. *Commentary (Holy Grail)*
3. S.Horike, S.Kitagawa, N*ature Mater.***2022**, 21, 983-985. *(Focus Comment*)