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Advanced Characterisation and Operando Spectroscopies|MOFs/Organic materials

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Confinement of nanoparticles in porous solids

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Abstract Text: Supported metal nanoparticles find important applications in catalysis. Controlling the size and distribution of nanoparticles on the support is critically to optimizing their activity and selectivity. The extended pore network in crystalline framework materials, such as metal-organic frameworks and zeolites, provide an ideal environment to confine the growth of catalytic nanoparticles as well as controlling access to the active site. The distribution of nanoparticles within the pores depends on the interplay between

1. the mobility of the metal species on the support surface,
2. the dimensions of the pores/channels in the support,
3. the dynamics of the porous framework, and
4. the growth habit of the nanoparticle phase itself.

By combining multiple complementary measurements sensitive to different aspects of the structure and chemistry, we can decouple these effects to build a complete picture of the mechanisms for nanoparticle formation and confinement. For example, we use pair distribution function (PDF) analysis to see the nanoparticles which are too small to be analysed using diffraction methods. We use complementary powder diffraction data combined with differential envelope density analysis to provide insight into the distribution of the nanoparticles within the pores. We use infrared spectroscopy to probe how changes in the chemistry of the pore surface impact nanoparticle mobility.