# Synthesis of mesoporous high-entropy PtPdRhCuIrSe particles by a chemical reduction method

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The development of high-entropy materials (HEMs) has garnered significant attention due to their exceptional properties and advantages. However, the structural complexity of multi-elements systems makes controlling their nanoscale morphology a big challenge.[1] Previously, we successfully synthesized metallic mesoporous HEMs (m-HEMs) containing Pt-group metals of Pt, Pd, Rh, and Ru.[2] However, the synthesis of metal-based m-HEMs with more metal elements, such as Ir remains challenging. Developing a simple strategy that allows for more flexible control over composition is a critical requirement.

In this work, a simple wet-chemical reduction method was employed to synthesize new m-HEMs. This approach involves micellizing a block copolymer in an organic solvent with water, followed by the addition of metal and Se precursors. Upon reduction process control, the metal and Se ions are reduced and aggregated, while the polymer introduces the porous structures. We found that the Ir content in m-HEM increases with the proportion of Se, leading to higher mixing entropy (Fig. 1). SEM, TEM and corresponding EDX images reveal a mesoporous structure with well-distributed elements, including Pt, Pd, Rh, Cu, Ir, and Se (Fig. 2a, b).

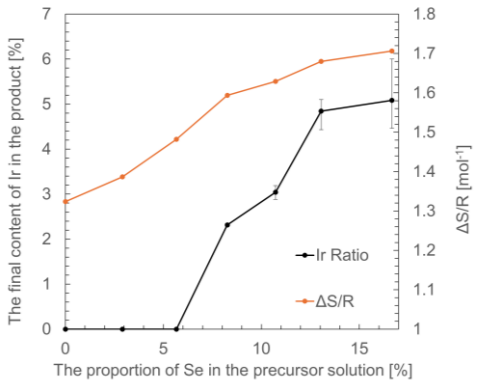


**Fig 1. Effect of Se amount on Ir composition and mixing entropy**

The result demonstrates the potential of utilizing chalcogen elements to enable the synthesis of m-HEMs with diverse compositions through a simple synthesis method.

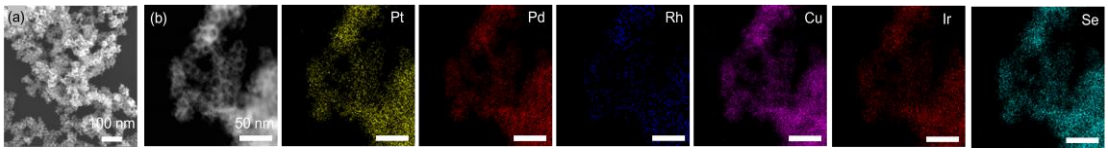


**Fig 2. (a) SEM image and (b)TEM-EDX mapping images of high-entropy PtPdRhCuIrSe**

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