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Highlight

Reversible Kirkendall effect enables the chemical transformation of reconfigurable nanocrystals

Li Zhai[1,2], Chao Wang[1], and Hua Zhang[1,2,3,4] ✉

[1] Department of Chemistry, City University of Hong Kong, Hong Kong, China
[2] Hong Kong Branch of National Precious Metals Material Engineering Research Center (NPMM), City University of Hong Kong, Hong Kong, China
[3] Hong Kong Institute for Clean Energy (HKICE), City University of Hong Kong, Kowloon, Hong Kong, China
[4] Shenzhen Research Institute, City University of Hong Kong, Shenzhen 518057, China

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The Kirkendall effect, a classical phenomenon in the metallurgical industry [1], has been used to construct hollow nanostructures with different properties compared to their solid counterparts [2, 3]. However, it is still challenging to control the morphologies, spatial arrangements of components, and crystal phases of nanostructures [4] by using Kirkendall effect-driven structural transformation.

Recently, novel conversion approaches beyond the traditional Kirkendall effect have gradually attracted researchers' attention, which could obtain nanostructures that are otherwise inaccessible by direct synthesis. For example, Shu-Hong Yu, Shi-Kui Han, and co-workers report a general Kirkendall effect-guided protocol for the reversible phase transitions between metastable metal chalcogenides (MCs) and metal phosphides (MPs) with controlled morphologies (DOI: 10.1021/jacs.4c10252) [5]. The team realizes reversible solid-to-hollow-to-solid structural motif evolution between $Ni_3S_4/Cu_{1.94}S$ and Ni_2P/Cu_3P nanostructures without morphology changes by employing ligand-regulated sequential extraction and diffusion of host/guest (S^{2-}/P^{3-}) anions. An in-depth mechanistic study demonstrates that the reversible transformation between metastable MCs and MPs is achieved by combining the ligand-dependent kinetic control and anion mixing-induced thermodynamic control.

As schematically shown in Fig. 1, this protocol presents a novel strategy for creating a library of reconfigurable nanostructures with tunable dimensions (one-dimensional (1D), two-dimensional (2D) and three-dimensional (3D)), components (metal-semiconductor and semiconductor-semiconductor), morphologies (core–shell, dotted, matchstick, Janus and hierarchical) and interfaces (crystalline-amorphous and crystalline-crystalline), which could further guide the controlled synthesis of nanostructures that are otherwise inaccessible by direct syntheses.

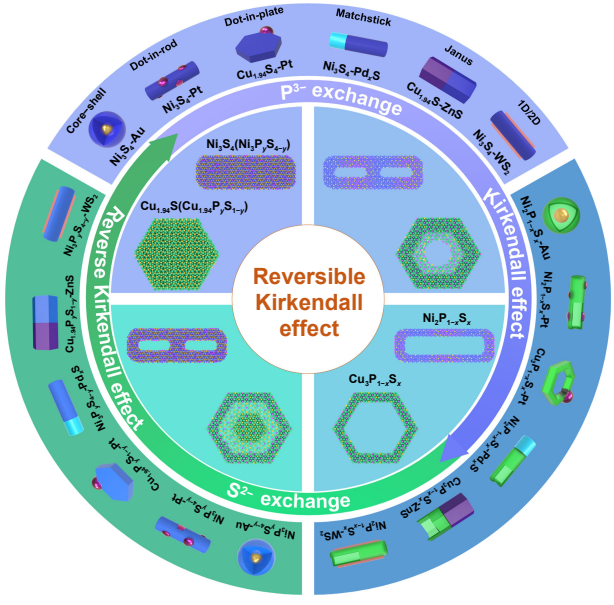

Figure 1 Schematic illustration of reversible Kirkendall effect-driven structural transformation of MCs and MPs.

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Received: December 7, 2024; **Accepted:** December 11, 2024 ✉Address correspondence to hua.zhang@cityu.edu.hk