Synthesis of Multi-Element Metal Sulfide Nanosheets

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Multi-element nanoparticles (NPs), including high-entropy alloy (HEA) NPs consisting of five or more elements with equal or relatively large compositions, have been intensively studied in recent years. Research on multi-element NPs has recently extended beyond alloy synthesis to include ceramics as well. Although alloys and oxides are the most common multi-element materials, multi-element metal sulfides have recently garnered increasing attention. The diverse range of their structures makes multi-element metal sulfide NPs more attractive because they offer not only compositional diversity but also structural diversity of exploration. However, due to synthesis challenges, there have been limited reports on synthesis of multi-element metal sulfide NPs.

In this study, we have synthesized novel multi-element metal sulfide NPs composed of early transition metals (Nb, Mo, and W) and 3d transition metals (Co and Ni), denoted as (NbMoWCoNi)S_x. The samples were synthesized via a facile wet chemical method using oleylamine solution and sulfur source (CS_2 or S). From transmission electron microscopy (TEM) image, it is suggested that the synthesized NPs have assembled structure of thin nanosheets (**Fig. 1a**). The powder X-ray diffraction (PXRD) pattern shows weak signals characteristic of the 2H-MoS_2 structure, indicating the nano-monolayer structure.

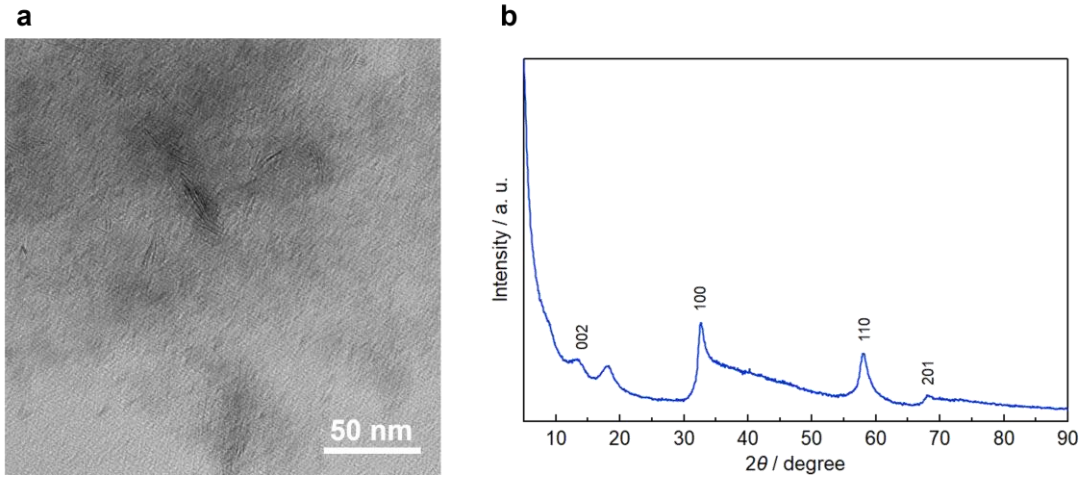

Fig.1 (a) The TEM image of (NbMoWCoNi)S_x NPs. (b) The PXRD pattern of (NbMoWCoNi)S_x NPs.