Researchers reveal stability origin of Dion-Jacobson 2D perovskites

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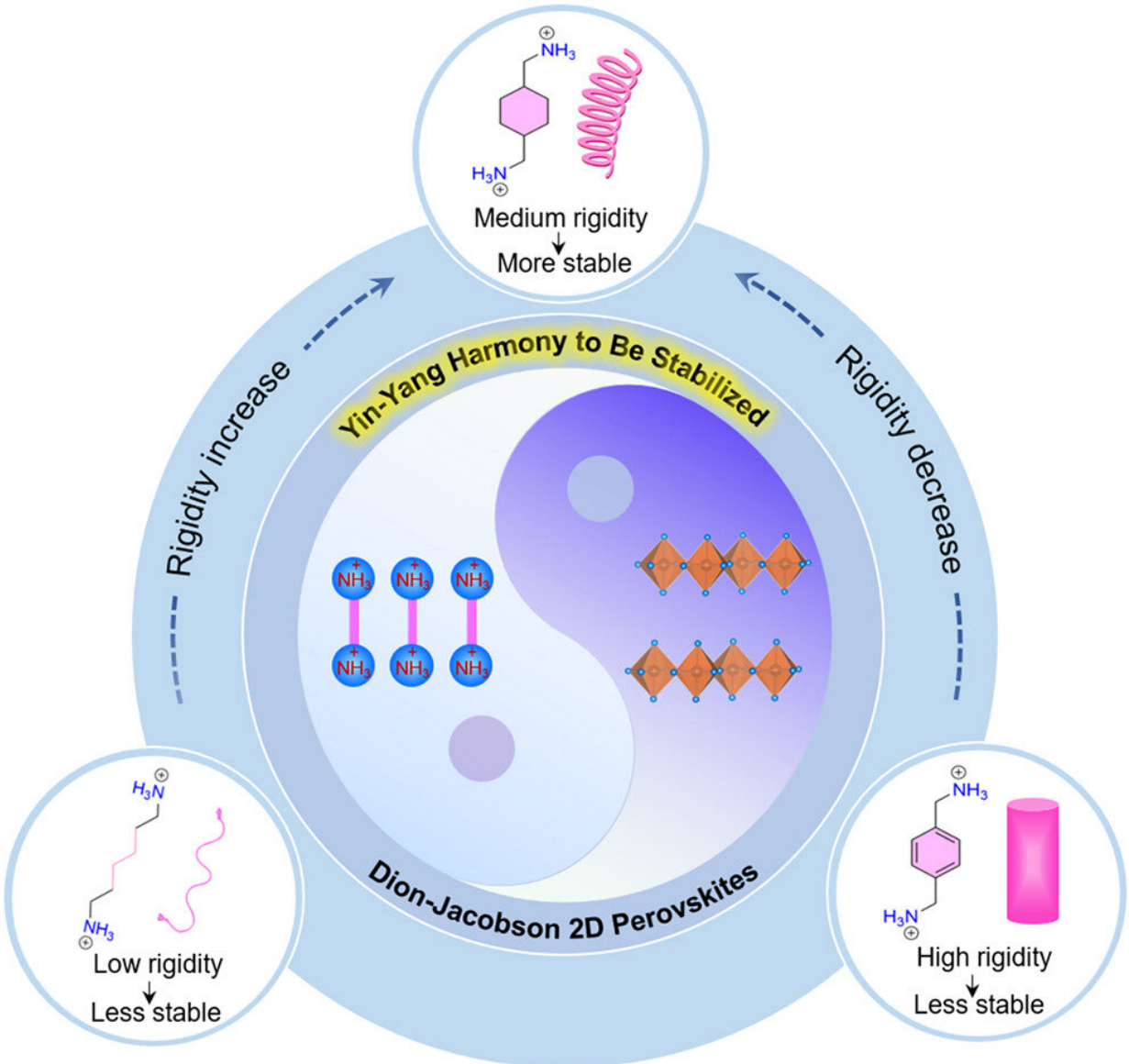

Graphical abstract. Credit: *Joule* (2023). DOI: 10.1016/j.joule.2023.03.010

Yin-Yang theory is an ancient Chinese philosophy in which Yin-Yang forces are interdependent and work in opposition to each other to create balance.

Recently, inspired by this ancient theory, a research team led by Prof. Guo Xin and Prof. Li Can from the Dalian Institute of Chemical Physics (DICP) of the Chinese Academy of Sciences (CAS) has revealed the origin of the stability of Dion–Jacobson (DJ) phase two-dimensional (2D) perovskite materials.

Their findings were published in *Joule*.

DJ 2D perovskites, a class of organic–inorganic hybrid perovskite materials, have been widely used for various optoelectronic applications.

Compared to traditional 3D perovskites with intrinsically low stability, 2D perovskites including the Ruddlesden–Popper (RP) phase and DJ phase are more attractive due to their enhanced stability, especially DJ 2D perovskites based on organic diammonium cations and inorganic lead iodide octahedra, which have higher structural stability than RP ones.

However, some of DJ 2D perovskites are not robust and even more easily degraded than RP 2D counterparts, which has led to a controversy over their stability. These contradictory research results have impelled scientists to clearly elucidate the stability mechanism of DJ 2D perovskites with different diammonium cations.

In this study, the researchers demonstrated that the stability of DJ 2D perovskites was determined by the rigidity of organic diammonium

cations, which could induce co-adaptation of organic and inorganic components to stabilize the 2D structure. Specifically, the medium cation rigidity allowed for organic diammoniums and inorganic octahedra to regulate their geometries in mutual accommodation in order to reach a stabilized state.

This mechanism may provide guidance for researchers who want to consciously manipulate the stability of DJ 2D perovskites by adjusting cation rigidity.

"Similar to the two parties in the Yin-Yang theory, organic cations and inorganic octahedra in DJ 2D perovskites are interconnected with alternating hydrogen bonds and when both parts can adjust their geometries to adapt to each other, strong connections are desirable," said Prof. Guo. "In this way, organic cations with moderate rigidity would play a critical role in the process of intercoordination because they have a certain degree of freedom to regulate the geometry and the inorganic part can correspondingly change its configuration as well."

More information: Yang Liu et al, Revealing stability origin of Dion-Jacobson 2D perovskites with different-rigidity organic cations, *Joule* (2023). DOI: 10.1016/j.joule.2023.03.010

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