Synthesis and Advances in Mixed-Anion Nitrides: Unraveling Structure-Property Relationships

H. Kageyama
Graduate School of Engineering, Kyoto University, Nishikyo-ku, Kyoto, 615-8581, Japan

Hiroshi Kageyama: kage@scl.kyoto-u.ac.jp

The strong covalent bonding nature of nitrogen imparts unique functionalities, such as blue LEDs, that are difficult to achieve with oxides. However, synthesizing mixed-anion nitrides is difficult due to the contrasting bonding characteristics between nitrogen and other anions. Our group has addressed these issues through topochemical reactions and high-pressure synthesis, successfully synthesizing new mixed-anion nitrides and nitrides. Key strategies include introducing anion vacancies [1], utilizing labile hydride anions [2], and suppressing volatile active anions [3].

This talk will highlight recent advancements in mixed-anion nitride synthesis and their properties. For example, low-temperature hydrogenation of orthorhomibic $Ca_3Cr^{III}N_3$ induces an unusual topochemical transformation to hexagonal $Ca_3Cr^{IV}N_3H$, resembling a hinged tessellation [4], and exhibits excellent catalytic performance for ammonia synthesis [5]. Sr-for-Ca substitution triggers a similar structural conversion without hydride insertion, resulting in a rare electride formation driven by negative chemical pressure [6]. Furthermore, we have developed a new layered nitride-hydride [7], which is related to the recently reported (but retracted) N-doped lutetium hydride in Nature [8]. Lastly, a novel solid state topochemical approach for synthesizing new oxynitrides will be presented [9].

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