Mixed anion compounds with functional properties

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Mixed anion compounds such as oxychlorides, oxychalcogenides, oxyhydrides and oxynitrides are an emerging class of materials with intriguing properties, including solar-activated photocatalyst $BaTaO_2N$, high-temperature superconducting iron pnictides, EuNbO2N with colossal magnetoresistance, spin liquid system $(CuCl)LaNb_2O_7$ and transparent p-type semiconducting system LaCuOS, to name only a few.
My talk will mostly focus on the synthesis, structure and properties of several transition-metal oxyhydrides. $ATi(O,H)_3$ (A = alkali metal) can be obtained in a topochemical fashion using CaH_2 reduction of the corresponding oxide hosts [1]. $ATi(O,H)_3$ is metallic with high carrier concentrations, though it fails to be superconducting at least down to 0.5 K [2]. Besides, hydride (H^-) ions are quite mobile at moderate temperatures, implying potentials of the oxyhydrides as ionic conductors and catalysts. Multistep reactions via oxyhydride will also be shown.
Mixed anion perovskite-based structures such as $SrCrO_2H$ and $MnTaO_2N$ can be prepared by high temperature and high pressure reaction [3, 4]. For $SrCrO_2H$, despite the non-bonding nature in Cr 3d and H 1s orbitals, the magnetic order temperature is as high as 380 K, which is significantly higher than those in isoelectric (Cr^{3+}. d^3) with $LnCrO_3$ (Ln = rare earth). This can be reasonably explained by octahedral tilting scheme.
We have prepared new titanium oxypnictides $BaTi_2Sb_2O$ and $BaTi_2Bi_2O$. A novel electronic phase diagram has been found in the solid solution $BaTi_2(Sb,Bi)_2O$, where two superconducting phases are separated by a metallic phase [5]. Similar phase diagram is also seen in high-T_c superconducting iron arsenides.

[1] Y. Kobayashi et al., *Nat. Mater.***11**, 507 (2012).
[2] T. Yajima et al., *J. Am. Chem. Soc*. **134**, 8782 (2012).
[3] C. Tassel et al., *Angew. Chem. Int. Ed*. **53**, 10377 (2014).
[4] C. Tassel et al., *Angew. Chem. Int. Ed*. **54**, 516 (2015).
[5] T. Yajima et al., *J. Phys. Soc. Jpn.* **82**, 033705 (2013).

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Fields of Research

Solid State Chemistry, Solid State Physics

Publications

1. Kageyama H. et al., *Phys. Rev. Lett*. **82**, 3168 (1999).
2. TsujimotoY. et al., *Nature **450**, 1062 (2007).*
3. Kawakami T. et al., *Nat. Chem.***1**, 371 (2009).
4. Kobayashi Y. et al., *Nat. Mater.* **11**, 507 (2012).
5. Frandsen B. et al., *Nat. Commun.* **5**, 5761 (2014).