Self-selecting vapor growth of transition metal halide single crystals

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Self-selecting vapor growth was developed about 50 years ago but has only been employed to grow II-VI and IV-VI semiconductors[1]. In this talk, I will show that this technique can be employed to grow sizeable single crystals of transition metal halide and chalcogenide. Transition metal halides can host a large variety of novel phenomena, such as magnetism in the monolayer limit, quantum spin liquid and spiral spin liquid states, topological magnons, and chiral phonons. Sizeable high quality single crystals are necessary for investigations of magnetic and lattice excitations by, for example, inelastic neutron scattering. However, typical vapor transport technique results in many small, physically separated crystals. In contrast, the self-selecting vapor growth can grow large single crystals by applying a rather small temperature gradient near the starting powder and letting the crystals form on top of the powder. I will report our growths of different transition metal halides, such as $RuCl_3$, $CrCl_3$, $Ru_{1-x}Cr_xCl_3$, and $CrBr_3$, and discuss the experimental design and challenges[2]. I will also briefly discuss our growths of transition metal chalcogenides by self-selecting vapor growth demonstrating its potential for providing high quality single crystals of other quantum materials. This work was supported by the US Department of Energy, Office of Science, Basic Energy Sciences, Materials Sciences and Engineering Division, and National Quantum Information Science Research Centers, Quantum Science Center.

References

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[2] Jiaqiang Yan, and Michael McGuire, Self-selecting vapor growth of transition metal halide single crystals, arxiv 2211.07806. (to appear in Physical Review Materials)