Ferromagnetism above 200 K in CrSBr enabled by Molecular Intercalation

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Molecular intercalation—the insertion of guest species into van der Waals (vdW) layered materials—offers a powerful approach to engineer quantum materials with tailored physical properties [1]. In particular, intercalation has emerged as a promising strategy to manipulate magnetism in vdW systems [2]. Among magnetic vdW materials, CrSBr has recently garnered significant interest due to its A-type antiferromagnetic order, characterized by ferromagnetic in-plane coupling and antiferromagnetic interlayer interactions, a Néel temperature (T_N) of 132 K, and a metamagnetic transition under applied fields [3]. Here, we report the successful intercalation of CrSBr with tetramethylammonium (TMA) and tetrapentylammonium (TPA), which introduce distinct interlayer expansions and doping levels. Magnetic characterization reveals a striking transition from antiferromagnetic to ferromagnetic order in the intercalated compounds (Fig. 1). The ferromagnetic phase retains the material's intrinsic in-plane easy axis along the *b* direction, but exhibits a significantly enhanced Curie temperature (T_C > 200 K), surpassing CrSBr's native T_N by over 60 K. The comparative study of TMA and TPA further elucidates the interplay between interlayer spacing, doping, and magnetic coupling, offering insights for designing advanced quantum materials with tunable spin interactions. These findings underscore intercalation as a powerful tool for unlocking emergent magnetic phenomena in layered systems, with potential applications in spintronics and quantum technologies.

References

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Figures

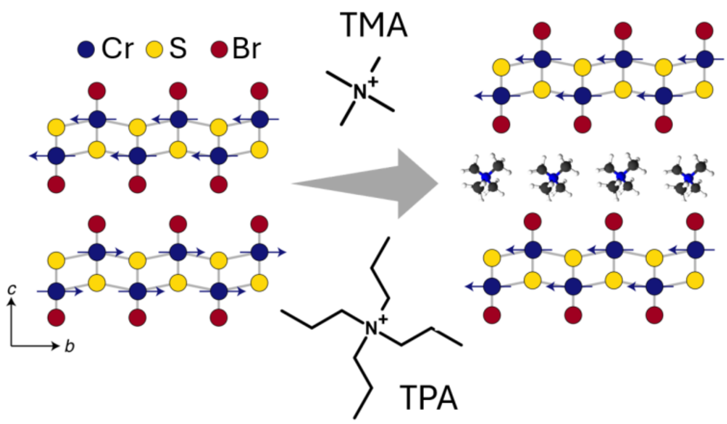

Figure 1: The intercalation of TMA and TPA induces a transition from antiferromagnetic to ferromagnetic ordering in CrSBr.