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High transition temperatures in molecular intercalates of FeSe¹

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Molecular groups can now be intercalated into iron-based superconductors with dramatic consequences on the superconducting properties. These species act as charge reservoirs, sources of electrical polarization, and also make subtle structural modifications to superconducting layers, all of which can make novel adjustments to the band structure that in turn can control superconducting properties. By synthesizing the compound $\text{Li}_x(\text{NH}_2)_y(\text{NH}_3)_{1-y}\text{Fe}_2\text{Se}_2$ ($x \sim 0.6$; $y \sim 0.2$), in which lithium ions, lithium amide and ammonia (NH_3) act as the spacer layer between FeSe layers, we have turned a 9 K superconductor into a 43 K superconductor [1]. Further chemical modification allow us to produce a range of new superconducting materials which we have studied using a variety of techniques including muon-spin rotation. Recently, we have used hydrothermal reactions to produce layered lithium iron selenide hydroxides with chemical formula $\text{Li}_{1-x}\text{Fe}_x(\text{OH})\text{Fe}_{1-y}\text{Se}$ and thereby producing compounds whose transition temperature can be tuned from zero up to about 40 K [2]. Minimizing the concentration of iron vacancies in the iron selenide layer and simultaneously increasing the electron count on iron in the selenide layers enhance the superconducting properties in this family. Future prospects for new superconducting materials using these novel synthetic routes will be discussed, as will also our current understanding of the superconductivity in these materials. (Work performed in collaboration with S. J. Clarke and coworkers at Oxford, RAL and Durham, UK.)

[1] M. Burrard-Lucas et al., Nature Materials **12**, 15 (2013).

[2] H. Sun et al. arXiv:1408.4350

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