Superconducting ferecrystals: turbostratically disordered atomic-scale layered $(PbSe)_{1.14}(NbSe_2)_n$ thin films

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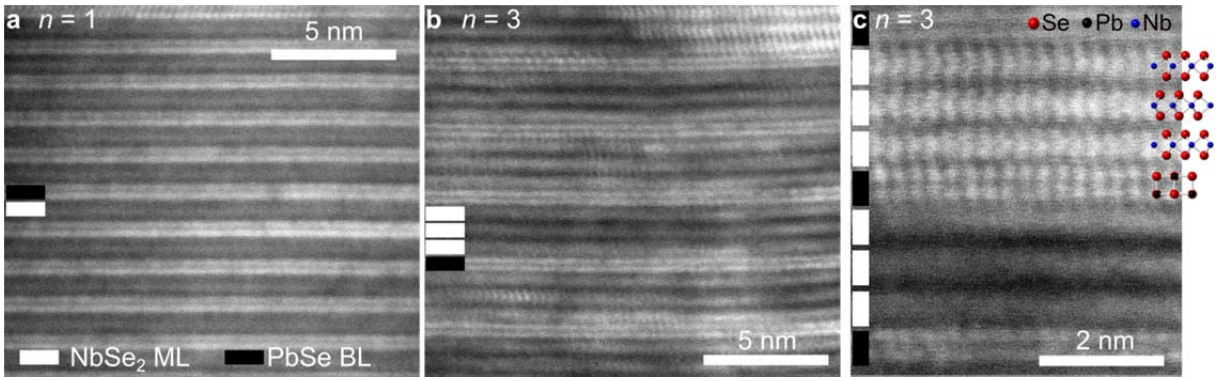
Short Abstract

Hybrid electronic heterostructure films of semi- and superconducting layers possess very different properties from their bulk counterparts. Here, we demonstrate superconductivity in ferecrystals: atomic-scale layered structures of single-, bi- and trilayers of $NbSe_2$ separated by PbSe layers. The turbostratic disorder between layers does not destroy superconductivity. Our method of fabricating artificial sequences of 2D layers structurally independent of their neighbours in the growth direction opens up new possibilities of stacking arbitrary numbers of hybrid layers by avoiding epitaxial strain. The observation of superconductivity and systematic Tc changes with nanostructure make this approach of particular interest for realising hybrid systems in the search of 2D superconductivity and the design of novel electronic heterostructures.



Above. Cross-sectional HAADF-STEM images of $(PbSe)_{1.14}(NbSe_2)_n$ ferecrystals. (**a**) The layer structure is shown on the atomic scale for n = 1. A $NbSe_2$ monolayer (ML) is indicated by a white bar and a PbSe atomic bilayer (BL) is indicated by a black bar. (**b**) HAADF-STEM image of n = 3. (**c**) High-resolution HAADF-STEM image of n = 3 showing single atomic columns. The atomic columns resolved in the PbSe layer agree with a projection of bulk PbSe along the [100] direction.