Epitaxial ferromagnetic VSe2 monolayers on superconducting NbSe2

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Combination of magnetism and superconductivity has been predicted to result in a novel phase of matter called topological superconductivity. This has recently attracted intense interest due to the predicted boundary modes hosting Majorana fermions and their relevance to topological quantum computation. Topological superconductivity has been experimentally realized in 1D in both engineered nanowire systems and in chains of magnetic adatoms on an superconducting substrate [1,2]. Very recently, these concepts have been extended to 2D by studying the edge modes around magnetic islands on superconducting substrates [3-5]. However, this type of systems are sensitive to the atomic scale details of the coupling between the magnetic layer and the substrate and in some cases, require interface engineering using an atomically thin separation layer. This creates a big challenge in real device applications and there clearly is a need for more robust experimental systems for the realizat io n of 2D topological superconductivity.

We propose a new platform based on the recently discovered 2D monolayer van der Waals ferromagnet vanadium diselenide (VSe2) that can be grown directly on layered materials [6]. Here, we report the growth of monolayer VSe2 by molecular beam epitaxy (MBE) on superconducting niobium diselenide (NbSe2) substrate. We characterize the electronic and magnetic properties by low-temperature scanning tunneling microscopy (STM) and macroscopic magnetization measurements. The demonstration of the coexistence of ferromagnetism and superconductivity in a hybrid van der Waals heterostructure will provide opportunities for the investigation of novel quantum phases of matter and open new possibilities for real-life devices applications.

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