

Preface

Two-dimensional superconductivity (2DSC) has been studied for a long time. In 1980's, 2DSC was experimentally demonstrated in amorphous thin films, for the sake of fundamental physics, e.g., superconductor–insulator transitions and the Berezinskii–Kosterlitz–Thouless transition. Although they are important as two-dimensional physics, it is difficult to grow into engineering field because the characteristics of the material were almost absent from the superconducting properties. Recently, however, 2DSC is attracting renewed interest not only as condensed matter physics but as material science since it becomes possible to grow single-crystal-like epitaxial films even in *one-atomic-layer thickness* owing to the state-of-the-art ultraclean surface preparation methods, promising for the engineering capability based on band structures of the materials. Actually, in such ultrathin 2DSCs, it has been demonstrated experimentally that interfacial effect and breaking symmetry cause remarkable enhancement of critical temperature and magnetic field. In this thesis, they are called “atomic thick superconductors” (ATSCs) to be distinguished from conventional metallic thin films, which aims to expand this frontier by finding novel ATSCs using the combination of molecular beam epitaxy and in situ electrical transport measurement in an ultrahigh vacuum chamber.

This idea is described in Chap. 1 in detail with a historical overview of superconductivity and the electronic structure of two-dimensional materials. Their theoretical background is explained in the next chapter. Chapter 3 is devoted to showing the principle and actual setup of the experiments. Thereafter, the thesis moves its focus onto the implemented experiments. Chapters 4, 5, 6 are based on the results published in the peer-reviewed journals as follows:

Chapter 4 Thallium Biatomic Layer

*2D Materials***4**, 025020 (2017).

Chapter 5 Thallium-lead Monatomic-layer Compound

*Phys. Rev. Lett.***115**, 147003 (2015).

Chapter 6 Intercalation Compounds of Bilayer Graphene

*ACS nano***10**, 2761–2765 (2016).

These articles are reedited to include unpublished data and consideration, with inclusive discussion given in Chap. 7. At the end of the chapter, I comment on the directions for future research based on the current work. I would feel amply rewarded for my efforts if this book becomes a piece of human knowledge and serve as an aid to social progress.

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Observation of Superconductivity in Epitaxially Grown
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In Situ Electrical Transport Measurements

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