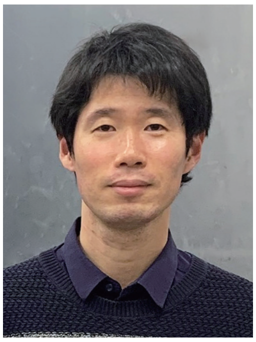
井手上研究室 Ideue Group

研究テーマ Research Subjects

1. 2 次元原子層物質の対称性制御を基軸とした新奇物性探索
   Exploration of novel physical properties based on symmetry control of two-dimensional materials
2. 原子層物質における量子状態測定
   Measurement of quantum states in atomic layer materials
3. 整流現象：非相反伝導現象、超伝導ダイオード効果、バルク光起電力効果
   Rectification effect: Nonrecirpcoal transport, superconducting diode effect and bulk photovoltaic effect
4. 原子層物質の相制御 : 磁性や超伝導、トポロジカル状態の制御等
   Phase control of atomic layer materials: Control of magnetism, superconductivity, topological states, etc.



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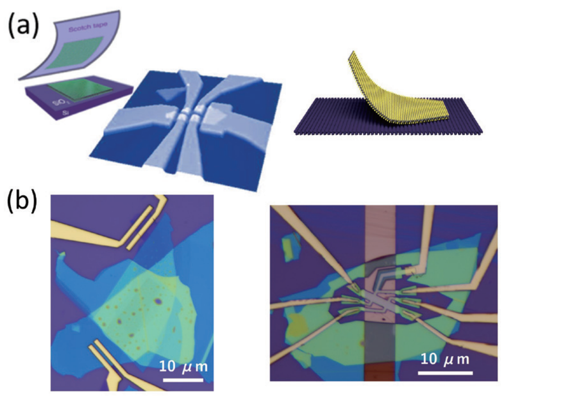
専攻 Course
工学系物理工学
App. Phys., Eng.

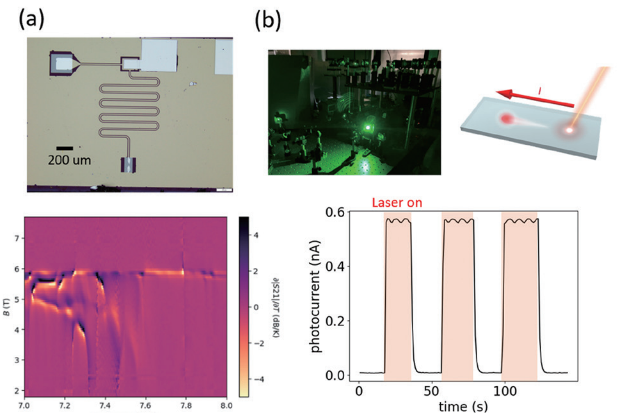
原子層数層からなる 2 次元物質は物質科学の新しい舞台として近年大きな注目を集めている。これらは 3 次元結晶にはないユニークな物性を示すことに加え、デバイス化や電場・磁場・圧力などの外場印加、電気化学的手法、曲率構造やヘテロ界面 / 捻り積層界面の作製等によって物質の構造や電子状態、対称性を自在に制御可能であり、それを反映した特徴的機能性を創出することができる。 本研究室では、そのような 2 次元原子層物質特有の電気伝導特性や超伝導物性、光学特性の発見と理解によって、物質科学のフロンティアを開拓することを目指している。電荷やスピン､励起子といった様々な量子自由度の整流効果や量子相制御、高周波を用いた量子測定に取り組んでいる。

Atomically thin two-dimensional materials have recently attracted significant attention as a new materials platform. In addition to the unique physical properties, which are absent in bulk three-dimensional materials, we can freely control the structures, electronic states and symmetries of two-dimensional materials and realize the emergent functionalities by device fabrication, application of the external pressure or electric/magnetic field, electro-chemical gating method, and making van der Waals hetero/twisted interfaces or curved nanostructures. We are exploring novel transport phenomena, superconducting properties, and optical properties in these two-dimensional materials and pioneering the frontier of material science. We are aiming at controlling the various quantum degree of freedoms or elementary excitations in two-dimensional materials (charge, spin, lattice, exciton, superconducting vortex etc.), realizing exotic quantum functionalities such as quantum rectification effect (nonreciprocal transport, superconducting diode effect, and bulk photovoltaic effect) and quantum phase control (electric-field-induced superconductivity, topological phase transition, magnetic order control), and also developing new quantum measurement techniques using microwave.



2 次元原子層物質の制御とデバイス作製。 (a) 劈開法による薄膜化と転写法による積層構造の作製。(b) 面直接合デバイスと電界効果デバイスの顕微鏡写真。

Controllability of two-dimensional materials and device fabrications. (a) Thin film device and van der Waals interface made by exfoliation, transfer and stacking techniques. (b) Pictures of vertical junction device and field-effect device.



(a) マイクロ波共振器と原子層物質の結合デバイスと共鳴モード (b) 顕微光学応答測定系と原子層物質ナノにおける光電流。

(a) Microwave resonator coupled with two-dimensional material and observed resonance mode. (b) Optical measurement system and photocurrent response in two-dimensional materials.

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