

論文 / 著書情報
Article / Book Information

題目(和文)	特異な金属カルコゲン化物コロイドナノ結晶の合成、構造ならびに電気特性
Title(English)	Syntheses, Structures and Electronic Properties of Unconventional Metal Chalcogenide Colloidal Nanocrystals
著者(和文)	MIRANTI RETNO
Author(English)	Retno Miranti
出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第11656号, 授与年月日:2020年9月25日, 学位の種別:課程博士, 審査員:松下 伸広,矢野 哲司,神谷 利夫,生駒 俊之,宮内 雅浩,SATRIA ZULKARNAEN BI,岩佐 義弘
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第11656号, Conferred date:2020/9/25, Degree Type:Course doctor, Examiner:,,,,,,
学位種別(和文)	博士論文
Category(English)	Doctoral Thesis
種別(和文)	要約
Type(English)	Outline

Syntheses, Structures and Electronic Properties of Unconventional Metal Chalcogenide Colloidal Nanocrystals

Thesis Outline

This thesis focuses on the study of unconventional metal chalcogenide colloidal nanocrystals (NCs): core@shell lead chalcogenide and tin chalcogenide for further functionalities. In the main part of this thesis, an effort to clarify charge carrier transport in core@shell lead chalcogenide PbTe@PbS NCs is demonstrated. In detail, the first part is represented in (1) demonstration charge carrier transport in core@shell PbTe@PbS colloidal NCs assembly (2) study of intrinsic properties of core@shell PbTe@PbS colloidal NCs assembly, and (3) investigation of stability enhancement in core@shell PbTe@PbS colloidal NCs assembly. On the other hand, the second part of this thesis presents a new synthesis route for environmentally friendly tin sulfide colloidal NCs.

This dissertation is divided into 7 chapters. Each chapter is described as follows:

Chapter 1 introduce the fundamental theory and motivation of this study. The main contents can be described into five parts: (1) The basic concept relating to colloidal NCs (2) Overview on the electronic properties of colloidal NCs and basic measurement of charge carrier transport (3) The general overview of core@shell colloidal NCs (4) Overview on tin chalcogenide NCs, and (5) The outline and chapters construction of this study.

Chapter 2 focuses on the demonstration of charge carrier transport in core@shell PbTe@PbS colloidal NCs assembly by a field-effect transistor (FET). PbTe@PbS FETs exhibit like an entirely n-type transistor with no indication of hole accumulation. This behavior is distinct from the core-only PbTe NC FETs which exhibits the signature of ambipolar transport, where both electron and hole current were observed. The comparison of FET properties between the PbTe@PbS and

the constituent core-only PbTe NC suggests that the hole transport was entirely suppressed by the shelling with PbS.

Chapter 3 provides a more precise measurement of intrinsic properties of core@shell PbTe@PbS NCs assembly by electron double layer transistor (EDLT). The EDLT PbTe@PbS NCs assembly demonstrated complete n-type transport behavior which is consistent with the solid-gated FET. Moreover, in this measurement, the suppression of hole transport becomes more apparent. Counter-experiment using p-type doping ligand Na_2S and TB(OH) is also provided. Due to the strong hole localization, both of S^{2-} and OH^- cross-linked PbTe@PbS persist its n-type transport behavior and did not show any indication of hole transport. This finding indicates that the shelling PbTe NCs using PbS results in the formation of a type-II internal heterojunction.

Chapter 4 present an approach to achieve improvement in conductivity and excellent stability as a means of iodide ligand. The role of iodide capping ligand in assembly and charge carrier transport in core@shell NCs is discussed. The FETs of iodide capped PbTe@PbS NCs assembly exhibit more stable electron transport characteristics. It suggests that iodide ligand plays a role to stabilize the electron transport of core@shell PbTe@PbS by passivating the remaining Pb dangling bond.

Chapter 5 focuses on the synthesized route, the study on the structure, and the size-dependent optical band gap of SnS colloidal NCs. The new synthesis method proposed in this study produces SnS colloidal NCs with controllable diameter and narrow distribution. The size-dependent quantum confinement effect in the SnS colloidal NCs is discussed.

Chapter 6 summarize and generally conclude the thesis.

Chapter 7 focuses on the discussion of the philosophical viewpoint, contribution, and prospect of this thesis.

The flowchart of this thesis is shown as follows:

