【International Leading Research】

Creation of quantum molecular electronics by fusion of advanced materials chemistry and quantum solid-state physics and fostering global researchers

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Purpose and Significance of the Research

●The aim of this international joint research

In this international initiative, organic chemistry researchers and quantum materials science researchers will be fused together to deepen the science and technology of organic CT and to create next-generation quantum molecular electronics. The first focus of this proposal is the creation of new luminescent molecules and their application to light-emitting devices, organic sensing devices, memory, thermoelectric devices, superconductivity, etc., based on CT phenomena, and the elucidation of the essential optoelectronic properties of molecules by ultrafast spectroscopy and single molecule measurement techniques from a fundamental perspective. The second focus is the establishment of essential organic device (ambient electronics) technology in various environments, such as in wearable devices and in vivo implantation. Organic devices currently require a strict environment that completely eliminates the effects of water, oxygen, etc. However, to expand their range of applications in the future, it is essential to construct materials and devices that are inherently highly compatible with water, oxygen, etc. without the use of encapsulation technology. If this can be realized, it will open up the possibility of devices that can operate on natural and environmental energy and devices with low environmental impact that can operate for long periods without maintenance by realizing self-healing and recovery, etc. Through these studies, we will further enhance the existing research field of organic electronics and develop the research field into quantum molecular electronics.

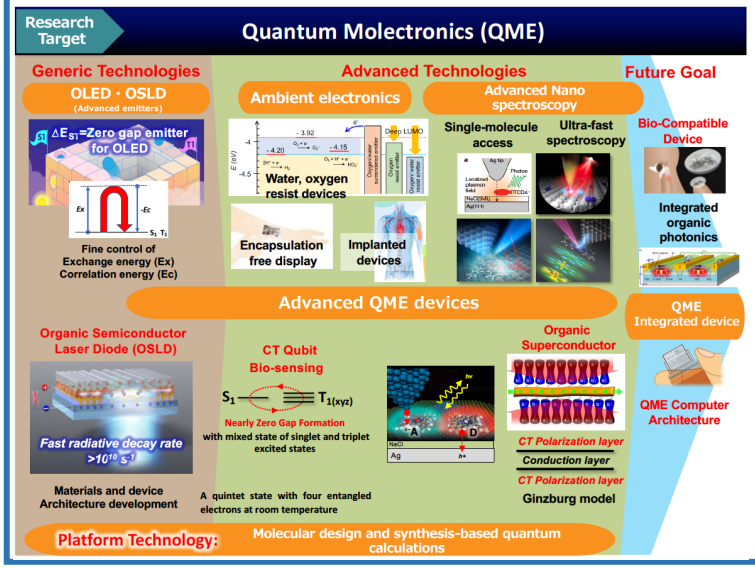

Fig. 1 Overall picture of quantum molecular electronics research aimed at by this research

Organization of the Project Team

●Fusion of Advanced Materials Chemistry and Quantum Properties

Based on the advanced results of organic optoelectronics by Adachi, Onda, Kim, and Hatakeyama, we will integrate our world-leading research in quantum properties with the organic molecular design and synthesis group to pioneer the next generation of QME. Together with overseas research teams, we aim to create novel quantum devices through the creation of innovative organic materials with a focus on physical properties centered on various quantum phenomena. The research team will work on advanced OLEDs, low-threshold organic lasers, polariton lasers, memory devices, thermoelectric devices, organic superconductors, organic quantum sensing, quantum bits, and so on. We will simultaneously deepen the organic CT science at the molecular and quantum levels through issues such as organic quantum sensing, quantum bit, and superconducting devices. To realize desired device functions, it is essential to study a variety of molecular structures of organic molecules, and we will promote the investigation of various molecular frameworks such as supramolecules and multiple resonance materials. In addition, AI and MI molecular design will also be conducted to establish a system to promote comprehensive molecular skeleton studies.

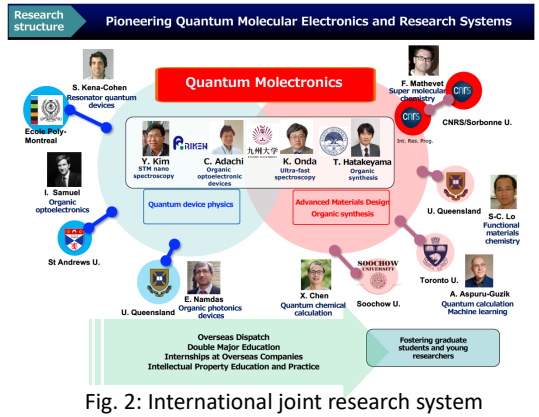

Fig. 2: International joint research system

Plan for Fostering Early-career Researchers

In this project, 11 principal investigators and co-investigators, 8 post-doctoral fellows, and about 10 graduate students are expected to participate. By organizing researchers in materials chemistry and condensed matter physics on a global scale, this project will promote the development of graduate students and young researchers who can promote QME research and development from the viewpoints of different fields in an integrated manner. In particular, we will actively exchange graduate students and young researchers who specialize in optoelectronic functional materials chemistry, and who specialize in quantum condensed matter physics and device physics, to pioneer the research field of QME. We prepare a variety of career paths and produce internationally active human resources, not only academically, but also through internships at global companies and employment at overseas research institutions. We will also promote entrepreneurship education with the future practical applications of quantum molecular.

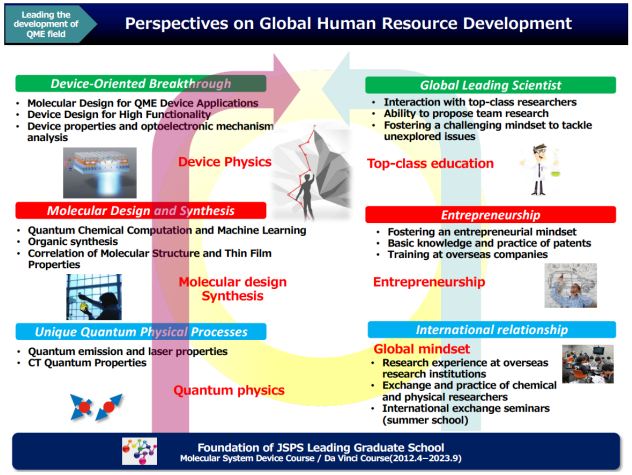

Fig. 3 Global Human Resource Development in QME

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