**Understanding physical properties for enhancing material functionality by using advanced electron spectroscopy methods**

**Graduate school / Start date**
Okayama University / Start date: 

**Job description**

This project will explore electronic structure (energy, momentum, and/or spin state of electrons) of new functional materials, such as superconductors, thermoelectric materials, and half metals by using advanced spectroscopic techniques to understand the microscopic mechanism and/or origin of the functionalities.

A variety of the properties that materials exhibit is intimately related to high energy electrons and elementary excitations, such as phonons and magnons. Therefore, experimental verification of the electronic structure near the Fermi level may lead to proper understanding of the mechanism and/or origin of the physical properties and actually gives a strategy to enhance and/or control the physical properties. Spectroscopic techniques are usually used to reveal electronic structure. Among them, high-resolution photoemission spectroscopy, which can detect the electronic structure directly, is considered to be a powerful experimental technique.

Our group is focused on the experimental determination of electronic structure to understand the physical properties of newly developed functional materials in the field of superconductors, thermoelectric materials and half metals, by using high-resolution photoemission spectroscopy and other spectroscopic techniques.

**Key-words**
Electronic structure, functional materials, superconductor, thermoelectric material, half metal

**Location: Okayama, Japan**
http://film.rlss.okayama-u.ac.jp/index_eng.html

**Profile & requested skills**
We seek highly motivated students with the solid scientific strength in physics and materials science. Excellent written English and oral communication skills are required. Some experiences of the following skills are desired and will be advantages: Spectroscopic techniques (photoemission spectroscopy and x-ray absorption spectroscopy), thin film synthesis, and programming skills for controlling experimental equipments and numerical simulations.

**Allowance**

**Supervisor**
Takayoshi Yokoya (yokoya@cc.okayama-u.ac.jp; Tel: +81-86-251-7897)
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Development of high-resolution photoelectron holography and its application to heavily doped diamond

Graduate school / Start date
Okayama University / Start date:

Job description

This project will develop high-resolution photoelectron holography, which observes local crystal structure around impurity atoms with different chemical states in crystals [Refs 1-2]. We will apply this technique to determine local atomic arrangements around impurity atoms in heavily doped diamond superconductors.

Diamond, which is popular as a gem, is a promising material for realizing high temperature superconductivity due to the light mass of carbon atoms and strong covalent bonding between them, both of which are key factors to enhance the superconductive critical temperature, $T_c$. However, $T_c$ of superconductive diamond is less than 10 K. The upper limit of $T_c$ is considered to be determined by the solubility limit of doped impurity atoms. Since carrier concentration is normally smaller than the concentration of doped impurity atoms in heavily doped diamond, improvement of the efficiency in doping is one of the strategy to increase $T_c$.

For this, knowing the local structure of impurity atoms with different chemical states, which has been difficult before, is extremely important. Research objective in our group is to develop high-resolution photoelectron holography at SPring-8 (synchrotron facility close to Okayama University), which determines the local structure around the impurity atoms at different chemical sites, and utilize this technique for the research of doped diamond superconductors to enhance $T_c$.


Key-words
Photoelectron holography, local structure, heavily doped diamond, superconductivity

Location: Okayama, Japan
http://film.rlss.okayama-u.ac.jp/index_eng.html

Profile & requested skills

We seek highly motivated students with the solid scientific strength in physics and materials science. Excellent written English and oral communication skills are required. Some experiences of the following skills are desired and will be advantages: Spectroscopy (photoemission spectroscopy and x-ray absorption spectroscopy), thin film synthesis, and programming skills for controlling experimental equipments and numerical simulations.

Allowance

Supervisor
Takayoshi Yokoya (yokoya@cc.okayama-u.ac.jp; Tel: +81-86-251-7897)
Professor,
Research Laboratory for Surface Science and Graduate School of Natural Science and Technology, Okayama University
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Materials simulation --- Ab initio, molecular dynamics, hybrid quantum/classical simulation

Graduate school / Start date
Okayama University / Start date:

Job description
Recent advances in parallel and GPU computing technologies have expanded the length scale of the systems dealt by molecular simulations up to angstroms which is optically observable. However, there are still difficulties in modeling the interactions between impurity atoms and nanoscale defects, and their effects on the macroscopic properties of nanostructured materials. This project will focus on effects of doping into nanoscale defects/interfaces on the materials properties such as mechanical, electrical and/or optical responses using various methodologies in computational materials science.

Our group has been investigating computational techniques for electron- and atom-level simulation, electromagnetic and sound wave simulation, and perform proof-of-principle experiments of the proposed materials/devices. In this project, we will mainly utilize simulation techniques based on the density-functional theory [1], classical molecular-dynamics method[2], and their hybridized algorithm[3].


Key-words
Density-functional theory, molecular dynamics, hybrid quantum/classical simulation, nanostructured materials

Location: Okayama, Japan
http://www.ec.okayama-u.ac.jp/~mdd/index.html

Profile & requested skills
We seek highly motivated students with the basis in physics and materials science. Excellent written English and oral communication skills are required. Some experiences on developing/running atomistic/quantum simulation codes and on analyzing their output data are advantageous.

Allowance

Supervisor
Kenji Tsuruta (tsuruta@okayama-u.ac.jp; Tel: +81-86-251-8142)
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Department of Electrical and Electronic Engineering, Graduate School of Natural Science and Technology, Okayama University
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Design and development of acoustic devices for energy harvesting
--- Phononic crystal, acoustic metamaterials/diode

Graduate school / Start date
Okayama University / Start date:

Job description

This project is aimed at designing novel acoustic devices for new energy-harvesting applications. We have recently proposed novel structures for controlling surface acoustic wave (SAW) at THz frequencies on piezoelectric nanostructures[1] and for rectifying Lamb wave propagation in thin plates[2] via designing phononic band structure of the materials. In the project, we will focus on further optimization of the proposed structures in order for energy-harvesting application, and/or experimental verifications of the designed properties.

Our group has been investigating computational techniques for electron- or atom-level simulation, electromagnetic and sound wave simulation, and perform proof-of-principle experiments of the proposed materials/devices. In this project, we will mainly utilize finite-difference time-domain (FDTD) or finite-element method (FEM) to design and simulate the acoustic devices. Also, some fundamental experiments on measurements of ultrasound propagation in the devices may be performed.


Key-words
Phononic crystal, acoustic metamaterial, acoustic diode, finite-element method, finite-difference time-domain simulation

Location: Okayama, Japan
http://www.ec.okayama-u.ac.jp/~mdd/index.html

Profile & requested skills
We seek highly motivated students with the basis in (applied) physics. Excellent written English and oral communication skills are required. Some experiences on developing/running the FDTD/FEM simulation codes and on analyzing their output data are advantageous.

Allowance

Supervisor
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