【Grant-in-Aid for Scientific Research(S)】

Integrated Science and Innovative Science (New multidisciplinary fields)

Title of Project : Creation and Evaluation of Complex Nanostructures Comprising Multi-Atom Species at Room Temperature by Atom-by-Atom Imaging, Chemical Identification and Manipulation

Seizo Morita
(Osaka University, Graduate School of Engineering, Professor)

Research Area : Compound New Area
Keyword : Nano Probe

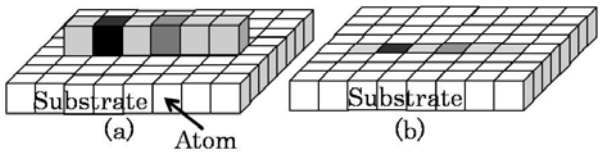
【Purpose and Background of the Research】

Complex nanostructures comprising multi-atom species show strong quantum confinement effect and, hence, we can design the confined electron energy. Atom manipulation and chemical identification of individual atoms are, however, critical to construct such complex nanostructures. Conventional nanostructures have been constructed from metal atoms and molecules weakly adsorbed on metal substrate by scanning tunneling microscope (STM) at low temperature (LT).

In this project, we will create and evaluate complex nanostructures comprising multi-atom species at room temperature (RT) by atom-by-atom imaging, chemical identification and manipulation of single atoms based on atomic force microscopy (AFM) combined with scanning tunneling microscopy (STM) [AFM/STM].

【Research Methods】

Using nanospace, we will investigate how to build up complex nanostructures supported on the semiconductor substrate at RT [Fig.(a)] by atom manipulation method. By atom interchange manipulations, we will also investigate how to build up complex nanostructures embedded in the semiconductor surface at RT [Fig.(b)].



Then we will evaluate various physical properties of created complex nanostructures with both functionality and quantum effects at RT using AFM/STM. Here, using AFM we will evaluate mechanical property, while using STM we will evaluate electronic property of complex nanostructures at RT. Moreover we will compare the nature of embedded complex nanostructures at RT with those supported on the surface at RT.

【Expected Research Achievements and Scientific Significance】

Multi-atom species are the origin of functionality of materials, while the nanostructure is the origin of quantum effects. Accordingly, complex nanostructures comprising multi-atom species combine the functionality of materials with the quantum effects and, hence, are the source of abundant novel nanomaterials and nanodevices. Using only the atom manipulation method, we can arbitrarily assembly complex nanostructure atom-by-atom. Thus, using AFM atom manipulation and AFM/STM characterization, we can create and evaluate complex nanostructures to search for valuable, novel complex nanostructures. Therefore, such investigations will open the gates to the novel field of physics and chemistry of complex nanostructures.

【Publications Relevant to the Project】

・ S.Morita, F.J.Giessibl, R.Wiesendanger (Eds.), “Noncontact Atomic Force Microscopy (Volume 2)”, Springer, ISBN: 978-3-642-01494-9, pp.1~401 (2009).

・ Y.Sugimoto, P.Pou, O.Custance, P.Jelinek, M.Abe, R.Pérez and S.Morita, “Complex Patterning by Vertical Interchange Atom Manipulation Using Atomic Force Microscopy”, Science, Vol.322, pp.413~417 (2008).

・ Y.Sugimoto, P.Pou, M.Abe, P.Jelinek, R.Pérez, S.Morita and O.Custance, “Chemical identification of individual surface atoms by atomic force microscopy”, Nature, Vol.446, pp.64~67 (2007).

【Term of Project】 FY2010-2014

【Budget Allocation】 159, 600 Thousand Yen

【 Homepage Address and Other Contact Information】

http://www.afm.eei.eng.osaka-u.ac.jp/
smorita@eei.eng.osaka-u.ac.jp