Project No. 02317 / Grant No. JPMXP0723833151

Report form of Joint Research Project at ZAIKEN (FY2023)

Title of Project	Nanostructured and multilayered ion-implanted alloys for environmental sensing		
Priority Area	III-B(Energy saving & Structures), III-C(Energy saving & Properties)		
	New proposal		
Name of Main Applicant	Hoang Nam Nhat		
Institution	VNU University of Engineering and Technology	**title**	Professor

Aim of the research project

Doped metal alloys are important for various applications of modern spintronics in environmental regulation and sensing. Some preliminary results on the gold hydride and/or carbide nanostructures have been published by our group previously (Nguyen K.T. et al., Mat. Trans. 56(9), 1383(2015); Nature Comm. 12, 1560 (2021)), part of which were supported by the ZAIKEN. The changes in structure and properties of the nano-structure alloys for application in reducing environmental pollution and energy consumption are investigated. The new materials are prepared using the heavy ion implantation technique offered by a Pelletron 5SDH-2 Linear Accelerator recently installed at Vietnam National University Hanoi. The characterizations have been carried out after preparation at Waseda University, Japan. The proposed materials include gold alloys doped with hydrogen and rare-earth $LaFe_{13}$-type alloys for energy purposes. The research consists of electro-magnetic responses of materials in broad bands, magnetic properties, high-temperature superconductivity, and other optical anomalies.

Contents and results of the research

In the current project, we have conducted the following:

1. The thin films of Au, Au-Fe, Au-Zn, Au-Al, $LaFe_{13}$, Cu-H, etc. were prepared by vacuum deposition technique at VNU. Preliminary characterization and measurements were carried out at VNU. (Dr. Le Viet Cuong)

2. Ion-implanted samples with La and H for dielectric, optical, and magnetic investigations: Doping concentration up to 500 μC. (Dr. Le Viet Cuong, Dr. Vuong Van Hiep)

3. Magnetic measurements at room and liquid nitrogen have been carried out in VNU and Waseda U. (Dr. Le Viet Cuong and students in Prof. Yamamoto's group)

4. Optical and magnetic measurements, structural characterization by means of advanced techniques such as Raman and UV-Vis and XPS have been carried out in Waseda U. (Dr. Le Viet Cuong and students in Prof. Yamamoto's group)

5. Temperature dependence of the XRD patterns have been observed at Waseda U. (Dr. Le Viet Cuong and students in Prof. Yamamoto's group)

6. Theoretical study using ab initio technique on obtained results will be carried out in both VNU and Waseda U. (Dr. Le Viet Cuong, Prof. Hoang Nam Nhat)

As an example of the results, XPS spectra taken in ZAIKEN, Waseda U. are shown in Fig. 1, in which increased binding energy was observed by doping La and H into Au films.

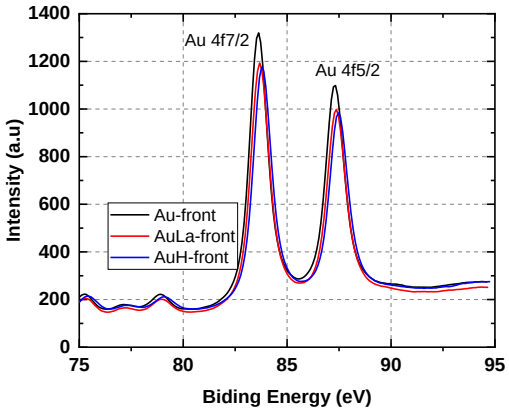

Figure 1. Observed XPS spectra of pure Au, La-doped, and H-doped Au films.

Outputs of the project (publications, presentations, patents)

Currently we are summarizing the results of the joint research to be presented in the international conference and published in the international journal.