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14. ABSTRACT

The work covered development of a semiconductor hetero-structures growth chamber to the existing photoemission chamber to characterize hybrid devices based on molecular solid/oxide structures. The work also investigated on developing optimum growth conditions for the desired Fermi level and work functions for different heterostructures.

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Annual Status Report : Characterization of Hybrid Devices Based on Molecular Solid/Oxide Semiconductor Hetero-structures

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We proposed a work under the title ‘Characterization of Hybrid Devices Based on Molecular Solid/Oxide Semiconductor Hetero-structures’ and submitted the work plan as detailed below. This annual status report is to present the current status of the proposed work.

Work Plan:

We proposed to build an annexed thin film sample/oxide contact growth chamber to the existing photoemission chamber, and to start initial stage of experiments on the systems with established optimum growth conditions. Our first year work plan therefore is overall divided into two stages – growth chamber building stage and performing initial stage experiments. Meanwhile, commissioning of the photoemission system is in progress and should be done in parallel with the project.

1st Stage: Building a thin film/metal contact sample growth chamber.

- Conceptual design: In this stage, we determine what features go into the chamber and how they are arranged. It will be determined based on overall budget, experimental needs and possibility of future upgrade. The chamber tentatively will include a multi source evaporator for metal (for oxide contacts), an effusion cell (for organic materials), a thickness monitor, manipulator with an XYZ stage, sample transfer system, pumping system among other. (Expected time need for the stage: 0.5 month)
- Detailed design: This stage covers detailed design process and actual CAD work. Geometrical dimensions and accessibility of the chamber are two factors that need to be seriously considered. (Expected time need for the stage: 1 month)
- Manufacturing: In this stage, the chamber will be manufactured. It will be done by an outside manufacturer. There are experienced manufacturers for sample growth chambers. (Expected time need for the stage: 1.5 months)
- Testing chamber: Once the chamber is delivered, vacuum, and sample/metal contact growth should be tested. This test includes growing thin film samples

with a known recipe as well as device characterization made from the thin film sample. (Expected time need for the stage: 3 months)

2nd Stage: Initial Stage Photoemission Experiment on Organic Thin Film/Oxide Contact Samples:

The 2nd stage of the project will focus on the initial stage photoemission experiments on organic thin film/oxide metal contacts. It is 'initial' because the experiment will be performed with a He discharge lamp in stead of the ultimate gold of using the bulk sensitive laser as the light source. Through this process we will test whether we can perform:

- Sample growth and transfer of it to the photoemission chamber
- Taking photoemission spectra from organic samples
- Measuring the Fermi level position in the gap
- Work function measurement through secondary electron cut off position measurement.

The 2nd stage will last until the end of the 1st year of the proposal.

Status Report:

- Conceptual design: We consulted with an expert vacuum scientist on conceptual design of the chamber. Following his suggestion, we decided to split the sample growth chamber into to: Preparation chamber and the deposition chamber. It is to avoid contamination of the prep-chamber to achieve the high vacuum. The conceptual design is completed.
- Detailed design of the chambers: As shown in the figure in the page, actual design of the chamber is in a smooth progress. The preparation chamber includes metal evaporator for electrodes, and LEED for oxide surface characterization. Additional features are RGA and XYZ manipulator, e-beam heaters for annealing. The organic growth chamber has a Turbo pump, ion pump, transfer arm, and evaporator (effusion cell type)
- Additional improvement of the system: We also found a need to move the main turbo pump to the preparation chamber. This included additional design change of the whole system. (Please refer to the attached drawing for the design)
- Photoemission system test: Meanwhile, we have installed a discharge lamp and performed initial test of the photoemission system. The result is that the system is working well and is ready for the new preparation chamber and organic growth chamber.