

Master Thesis

Deposition of novel materials using molecular beam epitaxy for photovoltaic applications

Subject area:

Molecular beam epitaxy (MBE) offers high control of elemental flux for thin film deposition. Our system contains 7 different elements in their pure elemental sources enabling us to deposit the compound of our choice. This provides an opportunity to make and deposit new materials that have not been studied before. Hence, we can make an alloy of two different materials to make a new material with a new set of properties. This thesis focuses on development of a new material for photovoltaic applications. Sb_2Se_3 has an ideal band gap (1.2 eV) for solar energy conversion, yet the maximum efficiency achieved to date is only 7.6 % (theoretical expectation 27%). Among many possibilities of loss in efficiency, a major reason for its low efficiency is expected to be higher effective mass of electron. One of the reasons for higher efficiency in Perovskite solar cells is attributed to lighter effective mass of electron and higher mobility. Another related compound is Bi_2Se_3 which has a higher electron mobility (excellent for charge transport) but lower band gap (0.3 eV, not ideal for photovoltaic applications). Hence, in this work we plan to make an alloy of Sb_2Se_3 and Bi_2Se_3 ($(\text{Sb}_x\text{Bi}_{1-x})_2\text{Se}_3$) and search for a good value of 'x' which yields a reasonable band gap for solar energy conversion and also high electron mobility.

Our MBE system is equipped with Reflection high-energy electron diffraction (RHEED) which enables us to monitor the growth in-situ during thin film deposition. Growth behaviour of thin films and changes in lattice constant will be monitored using RHEED.

This project is suitable for a Master thesis and the candidate will be in charge of deposition of materials using MBE and its characterization using RHEED. The project will be in active collaboration of RWTH Aachen where the structural (XRD/XRR) and optical characterization (FTIR) will be performed by the team.

Tasks:

- Deposition of $(\text{Sb}_x\text{Bi}_{1-x}\text{Se}_3)$ thin film using MBE
- Monitor of growth using RHEED and analysis using home built MATLAB based software
- Cleaning of substrates in cleanroom

Your Profile:

- The candidate should have a good background in solid state physics
- Knowledge of MATLAB (or related software) is desirable but not mandatory
- Decent written and communication skills in English

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