van der Molen lab:
Low-current LEEM: Non-invasive imaging

Supervision: Arash Tebyani (tebyani@physics.leidenuniv.nl) & Johannes Jobst (jobst@physics.leidenuniv.nl)

Motivation

Low-energy electron microscopy (LEEM) is well-suited for studying two-dimensional materials. One class of such materials are self-assembled molecular layers (Figure 1). However, electron beam intensities typically used induce damage in these layers, even for relatively short exposure periods. Furthermore, it is currently not possible to investigate materials with low conductivities in LEEM due to accumulation of charges on the sample surface, deflecting the incoming electrons and preventing measurement. To overcome these limitations, in this project we will try to make the LEEM electron gun operational with lower emission currents. Due to noisiness of current measurements at lower values, it is not possible to simply set a low emission current set-point for the gun; instead, a relation between the extraction voltage used in the gun (Figure 2), and the emission current needs to be established, and exploited in order to set the extraction voltage to get lower current values.

Project

You will learn about the operation principles of the electron gun incorporated in the microscope, namely cold field emission. Based on measurements of extraction voltage and emission current, you will fit the data with a model. Based on that, you will reprogram the electron gun microcontroller to make it operational with lower emission currents than the current existing limit. Finally, we will investigate the effects of different electron beam intensities on layers of pentacene molecules.

Student profile

You are interested to learn more deeply about electron gun as a key component of electron microscopy, and interaction of electron beam with organic semiconductors. You are interested in programming a microcontroller.

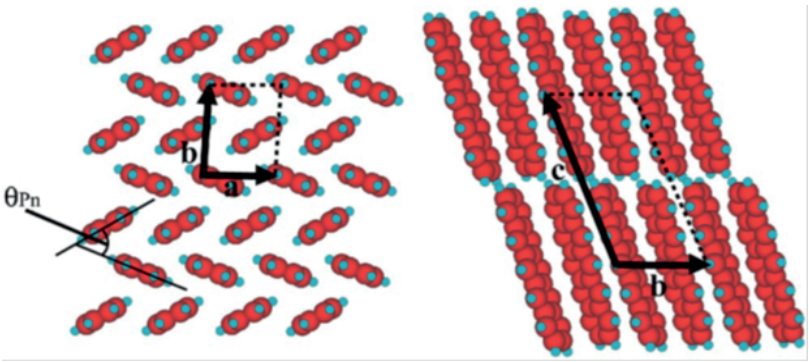

Figure 1. View of a pentacene layer from the top (left) and the side (right), taken from [1]

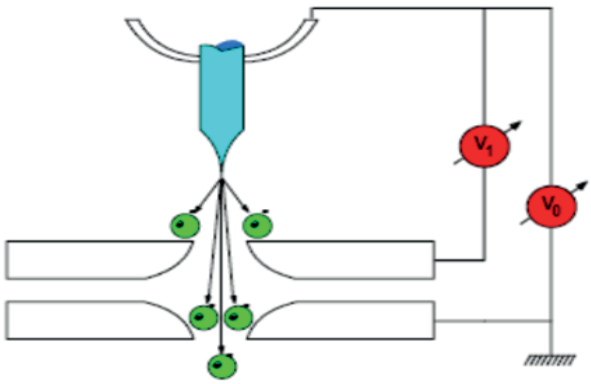

Figure 2. Schematic of a cold field emission gun. Electrons are ejected from the sharp cathode tip due to a high extraction voltage. Figure taken from Hitachi S-4700 FESEM manual

[1] H. Kakuta et al. , PRL 98, 247601 (2007)