

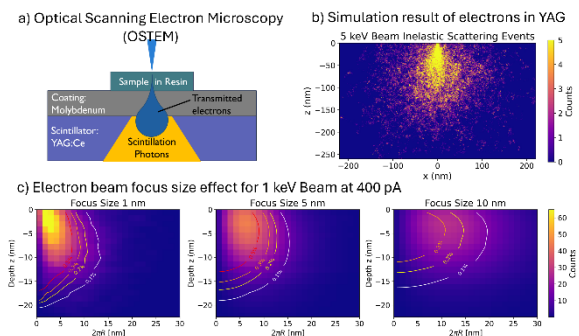
Understanding Scintillation in Focused sub-10keV Electron Beam Irradiation for novel Electron Microscopy Detectors

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The goal of this project is to increase throughput in biological Electron Microscopy, allowing for faster, large scale acquisitions at high spatial resolution through multi-beam imaging. Multi-beam detection relies on a novel detection technique called Optical Scanning Transmission Electron Microscopy (OSTEM), figure a) [1]. In this method a YAG:Ce single crystal scintillator is conductively coated and the thin (~100-200 nm) sample is deposited directly on the surface of the coated scintillator. Electrons transmitted through the sample and the coating generate photons by triggering scintillation events in the YAG, which are then detected on the transmission side. In this way the signals from multiple beams can be spatially differentiated and thus detected simultaneously. For high-throughput microscopy, optimal conversion to scintillation photons is essential. However, the conditions under which conversion takes place are different from situations more commonly studied. First, the focused electron beam irradiation means electrons entering the scintillator will be spatially concentrated. Second, the energy used is typically in the order of 5 keV with additional energy loss in sample and coating. We aim to understand how these circumstances influence the conversion yield of the scintillator by developing a model to describe the signal generation process. The proposed model uses electron-matter simulations in NEBULA [2] to simulate inelastic scattering in YAG, which deposits energy into the scintillator, figure b). This can lead to the excitation of cerium dopants. We filter the scattering events to only consider those events that deposit energy in the range capable of exciting the cerium band gaps. We further consider the possibility of spatial saturation of the scintillator. Since the beam is focused, scattering events happen in a limited volume strongly depending on the actual focus size of the beam, figure c). We describe spatial saturation by comparing the cerium density with the energy loss density within a given volume. If more events happen than cerium dopants can be excited, saturation occurs. We compare simulation results obtained with this model to experimental results. Ultimately, an experimentally validated model will allow us to fundamentally investigate low energy electron-photon conversion in focused electron beam irradiation of YAG:Ce single crystals and thereby optimize OSTEM as a high-throughput microscopy technique.



References

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