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Electron induced physical-chemical modifications - towards quantitative data

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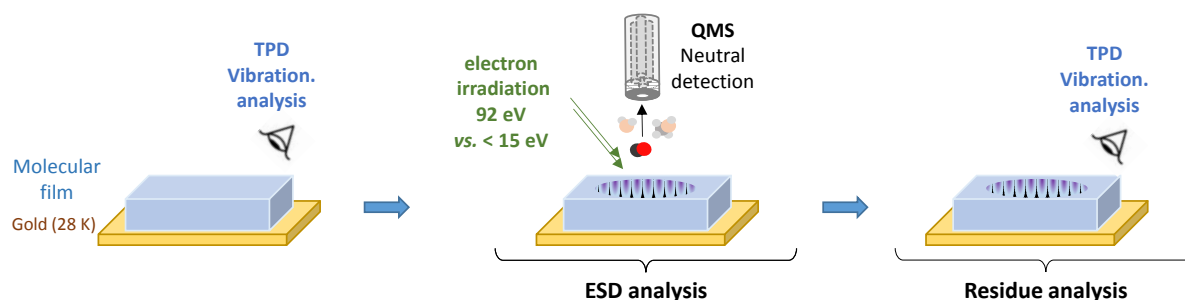
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Focused Electron Beam Induced Deposition (FEBID) and Extreme Ultra Violet light (EUV) lithography involve the decomposition of molecular entities / films under irradiation by high-energy beams with energies well above any ionization thresholds. The large amounts of resulting secondary electrons, of low energies ($0 \leq E \leq 20$ eV), contribute significantly to the lithographic processing. The design of the precursor molecular entities is a key element for an efficient decomposition, optimizing the overall process. Of particular interest are the characterization of the precursor chemical evolution, the understanding of the dominant underlying chemical processes including the low-energy electrons (LEE) contribution, and the quantitative characterization of decomposition pathways.

In the “electrons-solids” UHV setup at ISMO, thin films of precursors are submitted to high-energy (92 eV) vs. low-energy (< 15 eV) electron irradiation. Damages leading to the release of neutral volatile fragments are probed “in operando” during the electron irradiation by quadrupole mass spectrometry (Electron Stimulated Desorption studies). The film residues and deposits are analyzed by Temperature Programmed Desorption (TPD).



First studies dealing with a potential copper precursor for FEBID focused on secondary low-energy electron induced decomposition. An efficient resonant mechanism was observed and the associated effective cross section was determined [1].

Electron irradiation at low-energy has been compared to electron irradiation at high-energy (92 eV) for thin molecular films of 2-(trifluoromethyl)acrylic acid, a model halogenated unsaturated compound [2] of potential interest for developing alternative EUV resists. A very complex chemistry has been observed at high-energy, showing a first kinetic order over a restricted low-fluence regime, and the production of hydrogen fluoride HF was ascribed to near 0 eV secondary electrons.

[1] L. Sala et al., *Beilstein J. Nanotechnol.* **9** (2018) 57

[2] R. Tafrihi et al., *in preparation*