

Gas-phase Fragmentation and Dissociation Dynamics of Novel Iron FEBID Precursors

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Focused Electron Beam Induced Deposition (FEBID) is an emerging method for 3D nano structure fabrication [1, 2]. Gas-phase FEBID precursors are introduced onto a surface, where a high-energy (keV) electron beam drives localized decomposition and deposition. For an ideal FEBID precursor molecule the metal ligand must completely dissociate and get deposited into the surface and the rest of the volatile components are entirely removed by the vacuum system. Furthermore, the width of the deposition must also correspond to the focal spot size of the guiding electron beam.

In reality, however, most FEBID precursor molecules undergo partial decomposition, causing a portion of the ligand molecules to be co-deposited and thereby compromising the purity of the deposition. Additionally, some of the precursor molecules undergo thermal decomposition and initiate autocatalytic growth due to the heat generated by the focused electron beam. The primary high energy electron beam also produces an avalanche of secondary low-energy electrons (ranging from a few meV to hundreds of eV). These secondary low-energy electrons can lead to partial decomposition of the FEBID precursor molecules, as well as broadening of the deposition [2]. Generally, electron beams with energies up to approximately 20 eV can undergo efficient bond cleave and form anionic fragments via Dissociative Electron Attachment (DEA), whereas above 20 eV, dissociative ionization (DI) is the dominant process and produces cationic fragments.

Consequent, there is a recent demand to design and study new FEBID precursor molecules with better properties to avoid partial decomposition or autocatalytic growth due to the increased temperature during deposition. The secondary low-energy electrons also play an important role in FEBID process. And it is important to study the gas phase fragmentation pattern of the potential FEBID precursor molecules due to the low (around zero to 100 eV) energy electron beam.

Recently we developed, Fe(CO)₄-methyl acrylate [3] and Fe(CO)₄-acrolein [4], two iron (Fe) containing FEBID precursor molecules as an alternative to the well-studied Fe(CO)₅ and studied both DEA and DI induced fragmentation pattern. In the presentation we will show and compare the low-energy electron induced dissociation of the three iron precursor molecules, Fe(CO)₅, Fe(CO)₄-methyl acrylate and Fe(CO)₄-acrolein. The energy integrated DEA peak for a selected energy range to Fe(CO)₄-acrolein is shown in Figure 1.

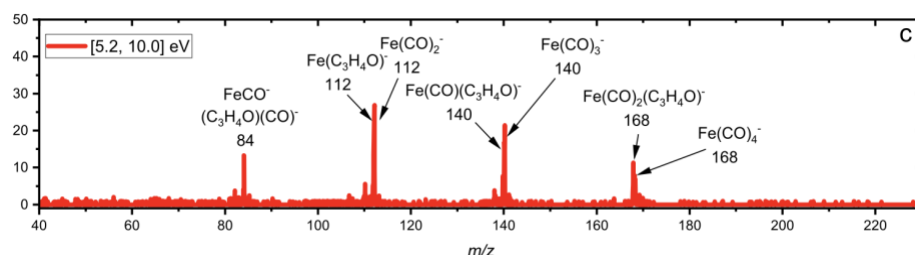


Figure 1. Energy integrated anionic mass spectra of Fe(CO)₄-acrolein molecule produced due to DEA.

Acknowledgements

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References

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