

Low-energy electron interactions with chromium hexacarbonyl $\text{Cr}(\text{CO})_6$

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Synopsis Positive and negative ion formation upon low energy electron interaction with chromium hexacarbonyl precursor molecules used in FEBID applications was studied. The obtained results revealed a noteworthy different fragmentation pattern compared to other precursors. This work contributes to the development and the possible production concerning highly pure nanoscale structures.

The technique of Focused Electron Beam Induced Deposition (FEBID) allows the development of functional three-dimensional nanoscale structures on surfaces using reactions of highly energetic (tens of keV) electrons and metalorganic molecules so called precursors. Major limitations in FEBID occur due to the purity-level of the created deposit, which influences the function and the resistivity of the deposit [1][2]. This limitation results as a consequence of incomplete decomposition of the precursor, i.e., the presence of precursor organic ligands. Another problem is the spatial resolution of the built nanoscale structure which leads to inadvertent surrounding deposit. Therefore the understanding of chemical reactions during FEBID is crucial so that the amount of impurities can be minimized, aiming for a pure deposit. In particular, it is assumed that both the purity and the spatial resolution of the deposit depend on interactions of the metalorganic precursor with secondary low-energy electrons [3]. These low-energy electrons are formed due to the interaction of the primary high-energy electrons with the precursor, the substrate, and the deposit.

Chromium containing compounds are used in FEBID as precursor molecules due to the high purity of the deposit-structure [1][4][5]. In this gas phase study, the interaction of organometallic chromium hexacarbonyl ($\text{Cr}(\text{CO})_6$) precursor molecules and low-energy electrons (between $\sim 0\text{--}70\text{ eV}$) was investigated. All measurements were carried out using a double focusing two sector field mass spectrometer in reversed Nier-Johnson geometry. This experimental setup allowed the investigation of positive and negative

ions as well as the dissociation of metastable ions in the microsecond timescale. The present results can be compared to a previous measurement with the precursor $\text{W}(\text{CO})_6$ [6]. Remarkably, a completely different anion yield pattern regarding the loss of CO-ligands is observed.

Like the anionic case, the formation of cations (Figure 1) indicated a strong sequential loss of CO-ligands. Additionally, the bare chromium ion ($\text{Cr}^+/\text{Cr}(\text{CO})_6$ and $\text{Cr}^-/\text{Cr}(\text{CO})_6$) was observed. This is in agreement with the high purity deposit measurements of $\text{Cr}(\text{CO})_6$ observed in FEBID.

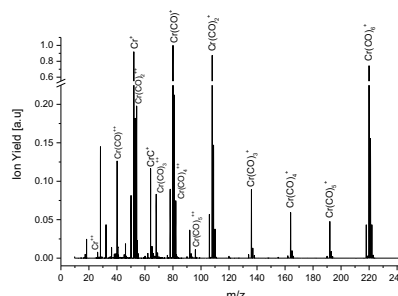


Figure 1. Ionization mass spectrum of chromium hexacarbonyl obtained at the electron energy of $\sim 70\text{ eV}$

References

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