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Electron-induced chemistry of cobalt tricarbonyl nitrosyl ($Co(CO)_3NO$) in liquid helium nanodroplets

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Synopsis Cobalt tricarbonyl nitrosyl ($Co(CO)_3NO$ - CTCN) is a widely used source for cobalt in focused electron-beam induced deposition (FEBID) processes. By doping helium nanodroplets at a temperature of 0.37 K with several $Co(CO)_3NO$ molecules we managed to create a multitude of molecular clusters and fragments. These clusters provide a similar environment to the materials used in FEBID. Dissociative electron attachment processes are hence studied in order to provide insight into factors limiting the achievable resolution in FEBID.

Focused electron-beam induced deposition (FEBID) is a promising technique to deposit metallic structures on substrates both in two and three dimensions. It consists of a jet of gaseous precursor molecules containing a metal compound and a focused electron beam. The electron beam is mostly produced by a scanning electron microscope and can be directed with sub-nanometer precision, hence allowing the printing of metallic films. However, due to the effects caused by secondary electrons, the actual smallest printable dot is two orders of magnitude larger than the precision of the electron beam position [1, 2]. Therefore, it is necessary to study effects of secondary electrons on the precursor molecules and investigate their potential dissociation channels upon DEA processes.

Here we focus on the potential precursor molecule cobalt tricarbonyl nitrosyl ($Co(CO)_3NO$). While a gas phase study is already available [3], a more realistic model for the actual FEBID environment might be given by clusters of the form $(Co(CO)_3NO)_n$ due to the involvement of thin layers of the precursor molecule in the actual process. We created these clusters by means of a helium nanodroplet source [4] and doping the pristine droplets with $Co(CO)_3NO$. Beside cluster formation, two more advantages over a pure gas phase study arise. One is the low temperature of 0.37 K, which quenches reaction channels possibly allowing the investigation of intermediate products. The other is the opportunity to add C_{60} as a model substrate to study the effects of a surface on the chemical processes involved.

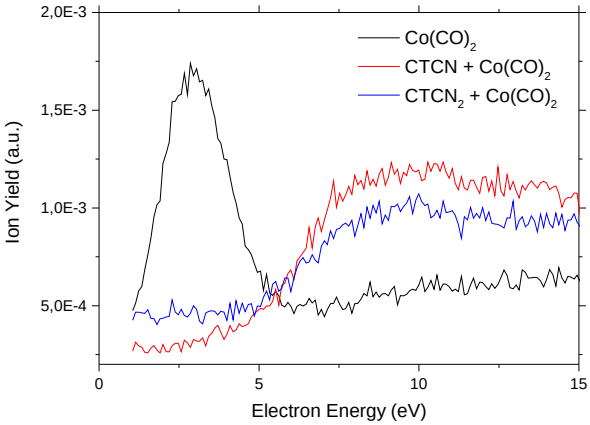

Figure 1. Anion yield profile for $Co(CO)_2$ in gas phase and attached to the $Co(CO)_3NO$ parent (CTCN).

We present anion yield profiles both for the gas phase and several clusters respectively their fragments. The cluster data show major differences when compared to the gas phase anion yields, as can be seen in figure 1. Preliminary data for $Co(CO)_3NO$ on a C_{60} surface will also be shown.

References

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