Mass spectrum processing of TriMethylAluminium embedded in liquid Helium

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Synopsis In this contribution we present the positive mass spectrum of TriMethylAluminium (TMA), which is one of the possible precursor candidates for FEBID. We have also determined and discussed the magic numbers of most prominent cluster series. We suppose that these cluster numbers are more abundant because of favourable structural conditions, but subsequent calculations have to be carried out to verify our assumptions.

Focused Electron Beam Induced Deposition (FEBID) is a direct-writing technique with nanometer resolution. After few decades of continuous development FEBID has reached a stage, when this technique is particularly attractive for several areas in basic and applied research [1, 2]. However, nature of precursors after collisions with electron beam and their subsequent fragmentation or clustering play a major role in FEBID process, therefore further research of precursors, among other things, is needed.

The positive mass spectrum presented in this contribution has been taken on the "ClusTOF" apparatus at the University of Innsbruck. In brief, Helium nanodroplets are produced by adiabatic expansion, then pass through the pick-up chamber, where investigated sample in gas phase is embedded into the droplets. The doped droplets subsequently pass through the ionization region and finally reach the time-of-flight mass spectrometer, where the produced ions are detected in a form of mass spectra [3, 4]. In this contribution we will discuss a positive mass spectrum of TriMethylAluminium (TMA), with chemical formula of $Al(CH_3)_3$.

Let's emphasize, that in processed spectrum we have identified hundreds of peaks forming tens of cluster series and in this contribution, we will present just the most prominent series.

The Fig. 1 contains signal derivative to cluster number plot of the most prominent cluster series of the positive spectrum. The series belongs to clusters of $[TMA]_{n-1}[DMA]_1$, which corresponds to loss of one methyl ligand from intact clusters of $[TMA]_n$. The magic numbers for n = 3, 6, 9, 12 and 15 are clearly observable. Each signal peak of these numbers does not necessarily have the highest signal intensity in spectrum, but it is almost as prominent as previous one. Moreover, a significant signal drop occurs at subsequent number. We assume that molecules of TMA under used experimental conditions are more likely to form clusters with mentioned cluster magic numbers, because of the favourable structures, probably with lower potential energy.

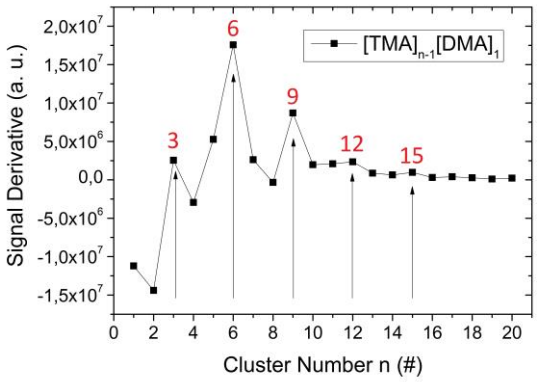

Figure 1 The signal derivative of most prominent TMA cluster series as a function of cluster number

So far however, these are just our assumptions, therefore theoretical simulations have to be carried out to verify them in order to bring deeper insight and understanding into nature of TMA and eventually more sophisticated FEBID applications.

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References

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