Limits to the chemical background and the mobility-selected current transmitted in a Differential mobility analyzer (DMA)

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OVERVIEW

Differential mobility analyzers (DMA) installed in the ion source region of API-MS instruments can convert a prevailing MS into an IM-MS instrument [1]. Here we investigate:

1. DMA-based DMAs require a high flow rate of inert gas (*~2000 ml/min*) moved by a mechanical blower, where high gas purity appears as harder to achieve than in conventional drift-tube mobility cells. Here we show that high gas purity is achievable with existing commercial blowers. This cleanliness leads to sharp mobility peaks without solution tails, enabling high-quality ion separation.

2. The claimed high ion transmission efficiency of DMAs has not been investigated in situations with high space charge, as when a nanosource is brought very near the inlet slit of the DMA. Here we demonstrate the ability to transmit ~1% of mobility-selected ions to the MS.

CLEANLINESS OF DMA CIRCUIT AND DYNAMIC RANGE

Knowing the shape of the short peak in a parallel plate DMA (DDMA, model ELD-3000) interfaced to a Sciex QTRAP-5500. The coupling permits fast removal of the DMA without breaking the vacuum. The ion source was an electric discharge in Ng. (Fig 2)

Maximum mobility-selected current transmitted by a DMA

The DMA receives a mixture of ions at its inlet slit, and works out all except those whose electrical mobilities are within a narrow range centered at a controllable value.

THE QUESTION: how high a current of mobility-selected ions can be transmitted given the high space charge conditions typical of a nanopore plume. The DMA immediately separates out the analytically interesting ions (of intermediate mobility) from the dominant space charge sources, including high mobility buffer ions (such as ammonium or acetate), as well low mobility clusters or incompletely shielded droplets. This separation works well in most cases to remove space charge effects from the analytically relevant ions. However, a space charge limit exists for the dominant ions in the plume, and it is this upper limit to the current which we propose to study here. This space charge limit leads to lateral broadening of the ion beam within the DMA, with important negative consequences on beam dilution and loss of mobility resolution.

We conclude on the basis of the short peak in a parallel plate DMA (DDMA, model ELD-3000) interfaced to a Sciex QTRAP-5500. The coupling permits fast removal of the DMA without breaking the vacuum. The ion source was an electric discharge in Ng. (Fig 2)

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