Sociedad Europea de Análisis Diferencial de Movilidad

SEADM

High Resolution DMA for Atmospheric Analysis
• SEADM is a Spanish SME founded in 2005, whose aim is to become a centre of excellence in the field of analytical instrumentation for the analysis of trace elements and nanoparticles, based upon the know-how of co-founder and Technical Consultant Juan Fernandez de la Mora.

• In the most recent and complete literature review on the integration of IMS and MS techniques, SEADM was cited as the generator and owner of two of the six most relevant current techniques, the TM-IMS and the DMA [Clemmer et Al., *J. Chromatography A, 1439, 2016, 3-25*] .

• Main company technology is actually Differential Mobility Analysis, upon which it holds 9 patents.

• Products:
  o Differential Mobility Analyzers
  o Ion sources
  o Electrometers
SEADM

DIFFERENTIAL MOBILITY ANALYZER

• Physical principle

![Diagram of differential mobility analyzer](image)

- No special preparation of samples
- Low qualification personnel
- High degree of automation
- Quick analysis (2 minutes)
- Continuous ion sampling / high duty cycle

• Resolving power higher than 80
• Ion transmission up to 50%
• Low ion residence times
• Usable with CPC or Electrometers
• Sample flow up to 10 Lpm
• Nanoparticle and molecule classifiers with optimum resolution

**HALF MINI**
- Range sub-1 nm to 30 nm
- Resolution 30 1/FWHM
- Size analysis studies

**DMA P5**
- Range one atom to 5 nm
- Resolution > 80 1/FWHM
- Ultra-high transmission (>50%)
- Nucleation, water uptake
The resolution advantage

Sheath flows up to 1,800 Lpm
Laminar flow at Re > 200,000 → Diffusion broadening minimized → Resolution maximized
Benchmark

DMA resolution benchmark

Resolution (peak voltage/FWMH)

SEADM's DMA P5  SEADM's Half Mini (p) model  Caltech  Grimm  TSI

The resolution advantage

STANDALONE DMA - PERFORMANCE

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Figure 2. New developments in the Half Mini model: (1) modification of the geometry, both the upper and lower “flaps” of the inlet slit to achieve a flow directly substantially downwards; (2) relatively large radius of curvature introduced in the lower lip to reduce jet separation and (3) perforated ring to further promote axial symmetry of the flow. From experimental evidence [Fernandez de la Mora, 2016], development (3) turned to be the most effective in the extension of the high resolution range.

Resolution close to the ideal

Half Mini DMA cylindrical cells performance using ovalbumin protein as test aerosol: a/(p) model; b/(p) model at medium to relatively high flow rates.
• DMA working as an Add-on for your favourite mass spectrometer

- Atmospheric research
- Proteomics
- Food Control
- Atmospheric nanoparticles nucleation
- Liquids and vapours
• Ouyang et Al.
“Investigation of the structure and stability of dimethylamine-sulfuric acid nanoclusters”

*J. Phys. Chem. A* 2015, 119, 2026−2036

Results shown on the left:
Mass-mobility contour plot inferred from DMA−MS measurement of multiply charged dimethylamine-sulfuric acid nanoclusters, with measured signal intensity expressed via color intensity on a logarithmic scale, with blue the most intense and yellow the least intense. Bands of ions of different charge states are labeled, from \( z = 1 \) to 7.

This study clearly showed that nanoclusters of dimethylamine-sulfuric acid uptake water at relative humidities beyond 10% near 300 K, and that larger clusters uptake water to a larger extent.
• Maisser et Al.

“Heterogeneous vapor uptake by single atom ions of both polarities using a differential mobility analyzer – mass spectrometer (DMS-MS)”

*European Aerosol Conference, Sept-2016, Tours, France*

“The results show that even for single atom ions the initial size of the seed influences the uptake rate. While the Kelvin-Thomson model can predict the expected shifts with satisfactory accuracy for positive ions, the current model fails to correctly predict the dependencies of uptake rates on size, charge and vapor polarity for single atom ions”.

*Figure 1. Experimental mobility shifts depending on the saturation ratio for all investigated ions*
• **Wang et Al.**

“Application of Half Mini DMA for sub 2 nm particle size distribution measurement in an electrospray and a flame aerosol reactor”

*Journal of Aerosol Science 71 (2014) 52-64*
Characteristic ion peaks below 2 nm were detected → clusters below 2 nm with high resolution.

Further help examine the initial stage of particle formation
SEADM’s Tandem Differential Mobility Analyzer (TDMA) enables to study a wide range of nano-aerosol processes by analyzing the change of electrical mobility experienced by the nanoparticles. Electrical mobility is a well-proved method to elucidate structural and size characteristics of ions, and has been successfully applied for the study of processes such as evaporation, condensation, chemical reactions, charge reduction (or charge evaporation), nucleation, etc.
**OUR CUSTOMERS REVIEW**

**F. Carbone (University of Yale)**  Interesting range: 1-50 nm

"The [Half Mini](https://www.seadm.com) DMA is a **robust and user friendly** instrument that has also a good configuration **flexibility** allowing to **personalize** the measurements strategy. The possibility of **classifying** even small ions offered by the instrument is greatly beneficial to unveil the **mechanisms of particle nucleation** even in challenging environments such as sooting flames".

Click to access Dr. Carbone’s full work

**A. Maisser (University of Vienna)**  Interesting range: sub-nm

"All ions measured had sizes in the sub nanometer range and thus other commercially available ion mobility spectrometers that operate at atmospheric pressure would not have met our needs in terms of **resolution or transmission**. This enabled **experiments at a new level of accuracy and precision**".

Click to access Dr. Maisser’s full work
SEADM

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