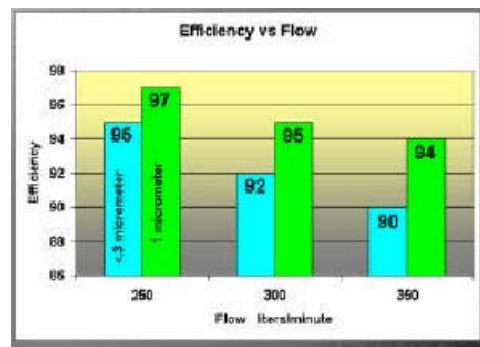




# Aerosol-to-Liquid Particle eXtraction System (ALPXS)\*

A new device developed at Savannah River National Laboratory collects **and concentrates** airborne metals into a liquid sample for onsite/real time or laboratory analysis. Useful as a tool for coupling ICPMS/OES to airborne particle analysis, the ALPXS can offer near real time sampling and analysis of welding fumes, workplace exposure measurement, or environmental metal particle monitoring. The device is portable and consumes only 12 watts of power.

- ▶ Uses wet electrostatic precipitation to separate particles from air.
- ▶ Collection efficiency is greater than 90% for particles less than 0.3 micrometers in diameter.
- ▶ Particles in air are drawn through the ionization chamber at a flow rate of between 200 and 300 LPM.
- ▶ Ionization chamber charges particles at 8000 volts.
- ▶ Particles are collected in a liquid reservoir with a volume of 10 - 200 mL.
- ▶ Liquid continuously washes collection electrode to gather particles during the measurement.



Collection Efficiency versus sampling air flow rate.

**Now, for the first time, you can potentially measure metal concentrations approaching picogram per cubic meter levels, or lower.**

## Comparison with OSHA PEM for Lead (Pb) Exposure

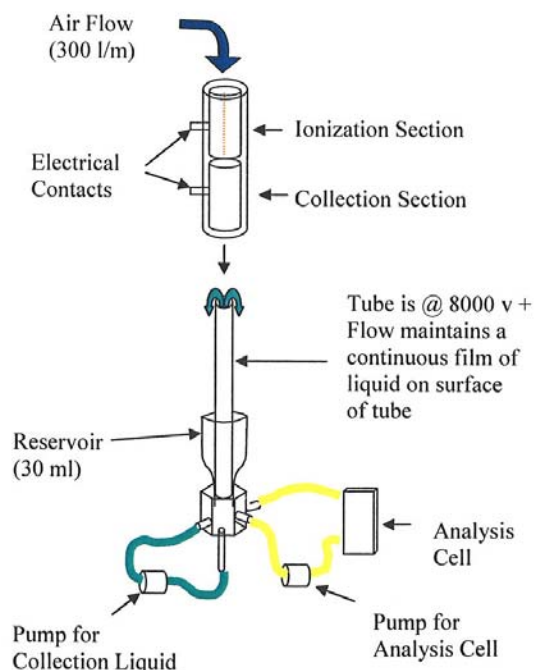
Device	Sampling Time, hr	Total Air Volume, m <sup>3</sup>	Pb ug/m <sup>3</sup>
ALPXS	0.8	14.4	4.8
OSHA PEM	2.5	0.3	2.7

\* Analysis for Pb by ICPOES

# Aerosol-to-Liquid Particle eXtraction System - ALPXS

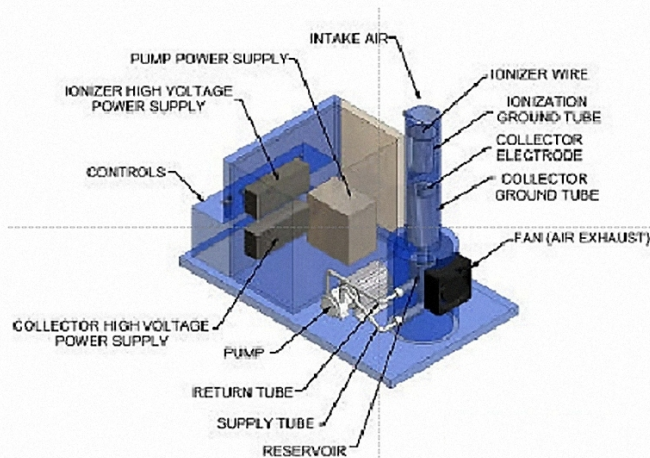
## Principle of Operation

- ▶ Air is drawn into the ionization chamber.
- ▶ Particles assume a negative charge.
- ▶ Collection electrode is maintained at positive high voltage and particles are attracted to it.
- ▶ As the particles migrate towards the collection electrode they are trapped by the liquid layer that continuously washes the surface of the collection electrode and accumulate.
- ▶ An auxiliary pump transports a very small fraction of the reservoir volume to an ICPMS, ICP-OES or AA for determination of metal species in the liquid.



## Technical Specifications

- ▶ Footprint: 8" x 8" with chimney height 23" (approx).
- ▶ Power requirements: 12vdc @ 1.25A, battery or converter.
- ▶ Air intake flow rate: 200-300 LPM
- ▶ Ionization voltage: 0-10kV, adjustable.
- ▶ Liquid reservoir volume: 20-100 mLs.
- ▶ Duty cycle: Continuous.



**ALPXS is a 2003 R&D 100 Award Winner**



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# Air to Liquid Extraction Device for Measuring Metals in Air

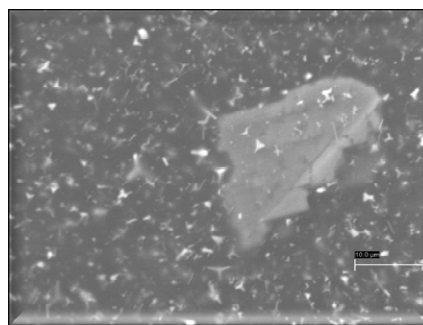
Gary Meyer, ProAnalytics LLC, Geoff Coleman and Bill Britt, Meinhard Glass Products  
Winter Conference on Plasma Spectrochemistry, Ft. Myers, FL, January 2010

## INTRODUCTION

- Air sampling for metals is done typically by trapping particles on a filter to concentrate.
- Filter based methods require long (many hours) sampling periods.
- Captured metals need to be separated (extracted) from the filter before analysis.
- Filter method can *undersample* due to penetration by particles smaller than the pore size.
- ALPXS uses NO filter to capture metals and can also capture NANOPARTICLES.
- Air sampling by ALPXS is **THE least expensive method for air quality surveying for metals currently on the market.**
- ALPXS can be fitted with adapters to perform localized, (worker breathing space), area, duct, or small chamber sampling.

## APPLICATIONS

- US Clean Air Act (CAA).
- National Emission Standards for Hazardous Air Pollutants (NESHAP).
- OSHA. (Be, Mn, Zn, Pb)
- Mixed metals smelters
- Pb battery recycling
- Steel mills
- Galvanizing plants
- Scrap preparation
- Spray painting booths
- Mining



SEM of particles captured from aerosol desolvating device produced for testing ALPXS. Sizes range from coarse to less than 1 micron.

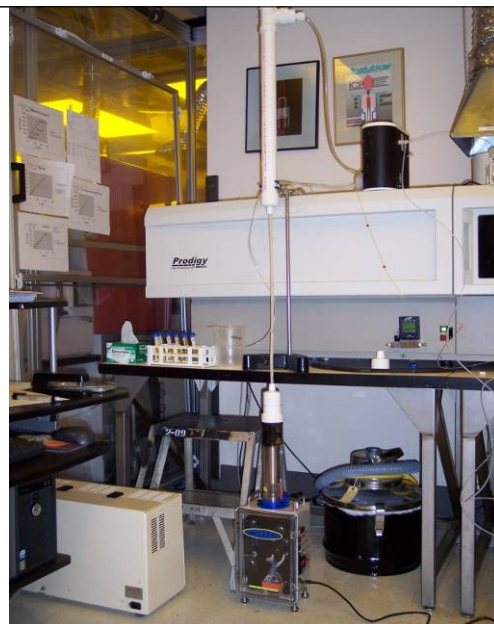
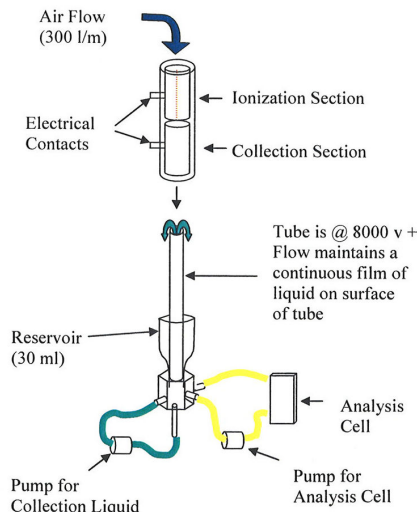
An aerosol desolvating system (Apex, ESI) produced dry aerosols of known concentration. Particle sizes were measured by SEM. Collected aerosol solutions were analyzed by ICP-OES (Prodigy, TLL). A variety of collection schemes were studied in an industrial workplace.



25" x 8" x 7" 12 Vdc, 2A

ALPXS is  
Aerosol to  
Liquid  
Particle  
eXtraction  
System

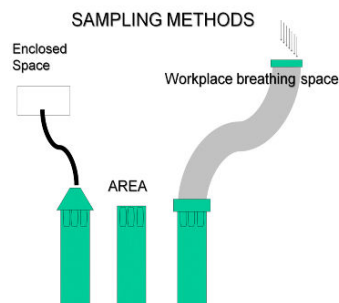
## Operating Principle



U.S. Patent 6955075, manufactured by Meinhard Glass Products, Golden, CO, under license from DOE Savannah River National Laboratories

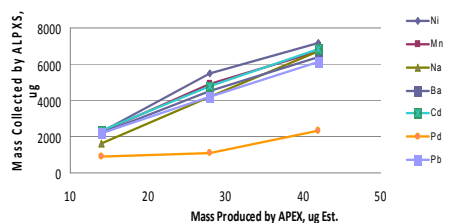
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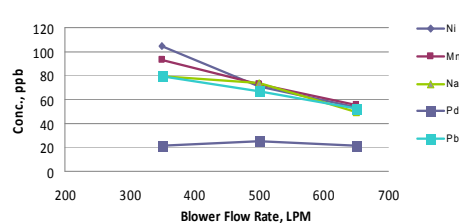


ALPXS can perform general area sampling (middle) or be fitted with special adapters for more localized / specialized sampling applications.

**APLXS ug Collected vs APEX ug Produced**

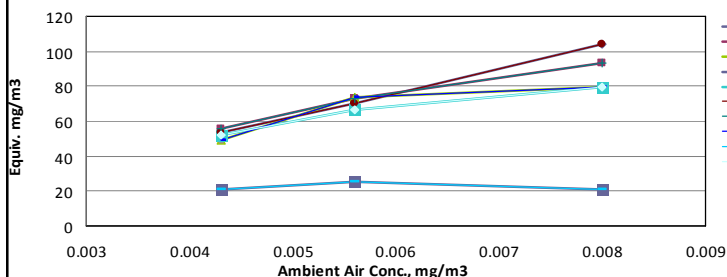


**ALPXS Collection ug vs. Blower Flow**



ALPXS collection efficiency study:  
vs. aerosol concentration  
vs. blower flow rate.  
Normal operation is 200 - 300 L/min.

**ALPXS Soln Conc. vs Air Conc**



Plot showing preconcentration factors for multiple elements. 10-minute sampling periods for each measurement.

Sampling Location	Cd, ug	Te, ug
Plant Location A <sup>1</sup>	2800	1340
Plant Location B <sup>2</sup>	120	40
Plant Location C <sup>3</sup>	180	na
Plant Location D <sup>4</sup>	50	na

1 Significant mechanical vibration of device, sampled using 2" air intake opening  
2 Normal plant air flow using 2" air intake opening  
3 Evaporation Duct using 5/8" sampling hose  
4 Thermal fixing station using 5/8" sampling hose

Particle masses collected at a manufacturing site at various locations around the plant.

**Comparison with OSHA PEM<sup>1</sup> for Lead (Pb) Exposure**

Device	Sampling Time, hr	Total Air Vol., m <sup>3</sup>	Pb <sup>2</sup> ug/m <sup>3</sup>
OSHA PEM	2.5	0.3	2.7
ALPXS	0.8	14.4	4.8

1 Personal Exposure Monitor  
2 Analysis for Pb by ICPOES

Comparison between filter sampling, OSHA recommended method, and ALPXS for the measurement of workplace breathing air concentration of Pb at a lead smelting plant.

## Conclusions

- ALPXS is designed for sampling particles in air directly into solution.
- Instrument is portable and can be powered by 12 vdc battery for up 8 hours.
- Air intake can be adapted to sample general area, workplace breathing zone, or a small chamber.
- Preliminary preconcentration factors of selected elements measured in the laboratory are as high as 13000 from ambient.

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