# Characterization of a New High Performance Inert Nebulizer for ICP Spectrometry

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Glass Expansion

GLASS EXPANSION
Quality By Design

# Characteristics of Concentric Glass Nebulizers

- High efficiency
- High precision
- Small droplet size
- Well understood
- Resistant to organic solvent
- Resistant to most acids
- Not resistant to HF

Nukiyama and Tanasawa equation*

$$d_{3,2} = \frac{585}{V}\left[\frac{\sigma}{\rho}\right]^{0.5} + 597\left[\frac{\eta}{(\sigma\rho)^{0.5}}\right]^{0.45}\left[\frac{10^3 Q_l}{Q_g}\right]^{1.5}$$

$d_{3,2}$ = Sauter mean diameter - (μm)
$V$ = Velocity difference of gas-liquid - (m/s)
$\sigma$ = Surface tension - (dyn/cm)
$\rho$ = Liquid density - (g/cm$^3$)
$\eta$ = Liquid viscosity - (Poise or dyn·s/cm$^2$)
$Q_l$ = Volume flowrate, liquid - (cm$^3$/s)
$Q_g$ = Volume flowrate, gas - (cm$^3$/s)

* S Nukiyama and Y Tanasawa, Trans Soc Mech Eng., (1938-1940)

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# Currently Available Concentric Inert Nebulizers

## OpalMist

- PFA body and insert
- 3% physical reproducibility
- Up to 15% TDS
- Up to 75um particles
- Highest purity
- 0.05, 0.1, 0.2, 0.4, 0.6 & 2mL/min models

## PolyCon

- Polyimide body and insert
- 2% physical reproducibility
- Up to 5% TDS
- Up to 75um particles (for high uptake model)
- 0.05, 0.1, 0.2, 0.4, 0.6, 0.8, 2 & 5mL/min

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# New DuraMist Nebulizer

- PEEK body and insert
- 2% physical reproducibility
- Up to 30% TDS
- Up to 75um particles (for larger uptake)
- 0.4 and 1.0mL/min uptake models
- Either 1.0 or 0.7 L/min argon flow

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# DuraMist Development Goals

- HF resistant concentric nebulizer
- Lower price than PolyCon or OpalMist
- Similar performance to PolyCon
- Tolerant of various sample types
- Approach performance specs of SeaSpray

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# Thermo ICAP 6300 Operating Conditions

| | |
|---|---|
| RF Power | 1350 W |
| Plasma gas | 15 L/min |
| Aux gas | 0.2 L/min |
| Neb gas | 0.65 L/min |
| Replicates | 3 |
| Sample flush time | 65 sec |
| Plasma view | auto |
| Max Integration | 15 sec |
| Analysis pump rate | 37 rpm |
| Pump tubing | Orange/white |

IsoMist 21° C twister spray chamber, D-Torch.

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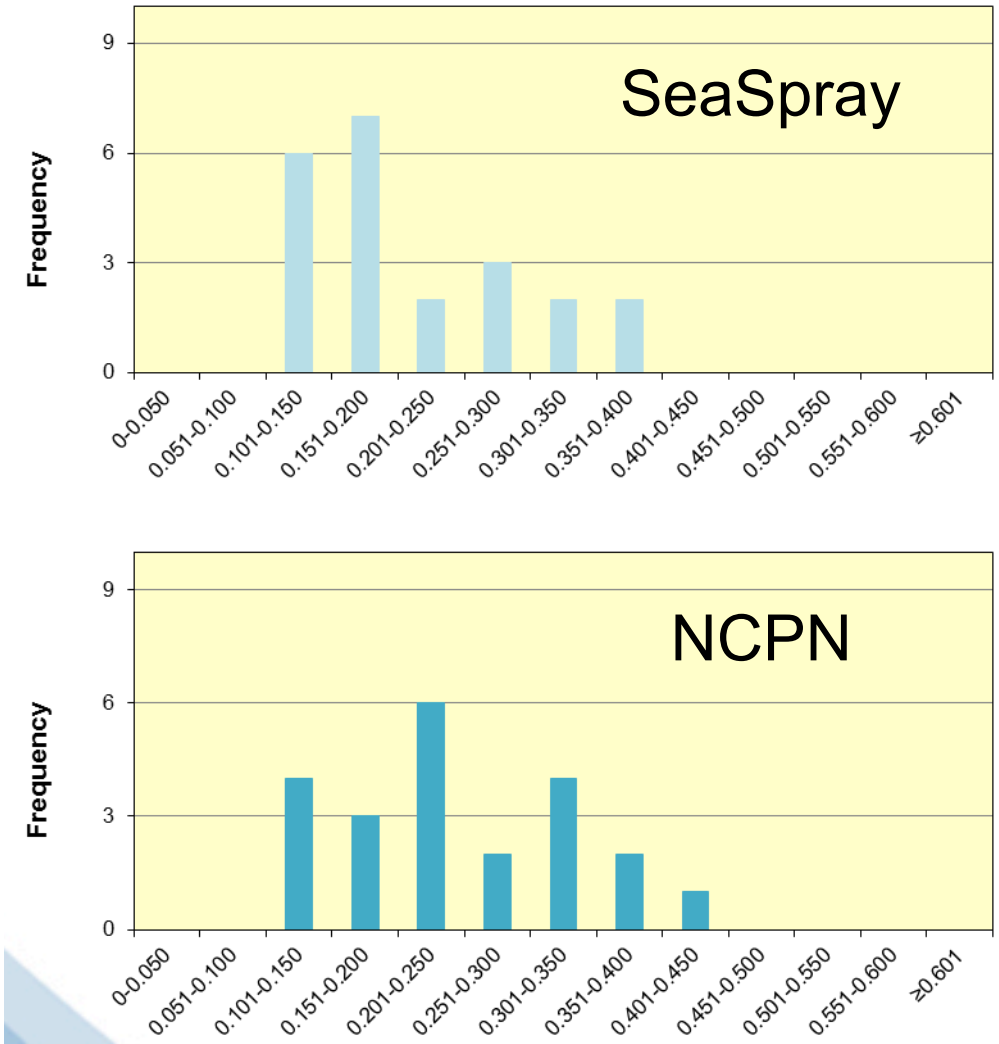
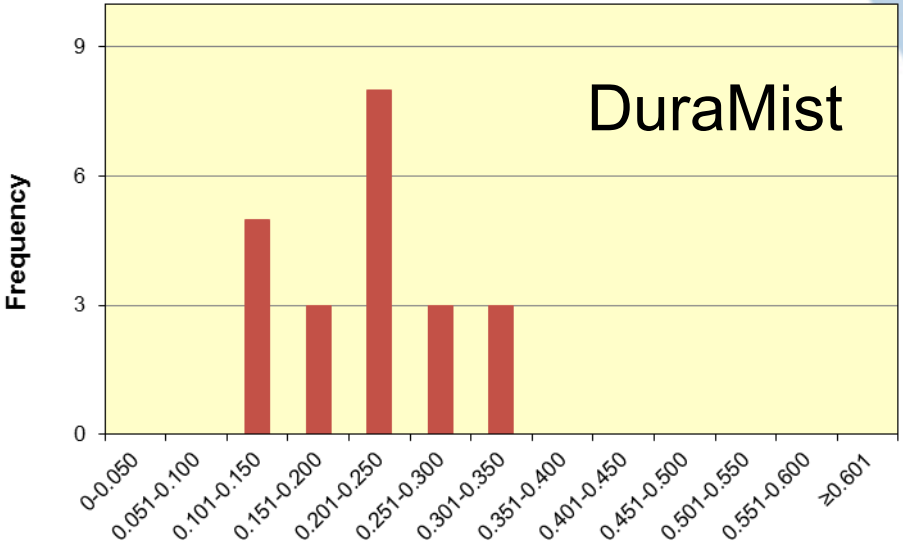
# Comparison of Precision










**NCPN = non-concentric polymer nebulizer**

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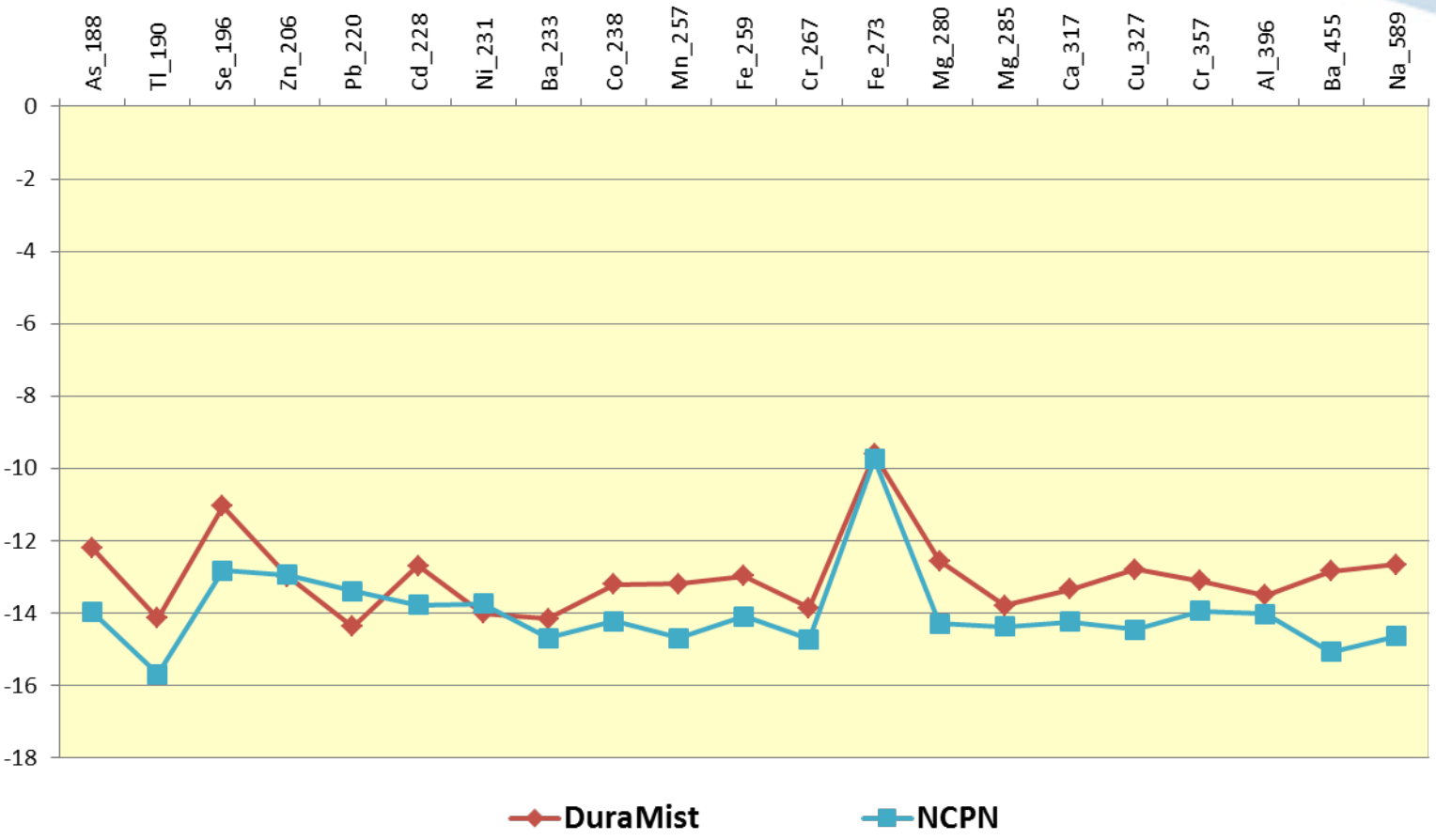
# Comparison of Intensity to SeaSpray

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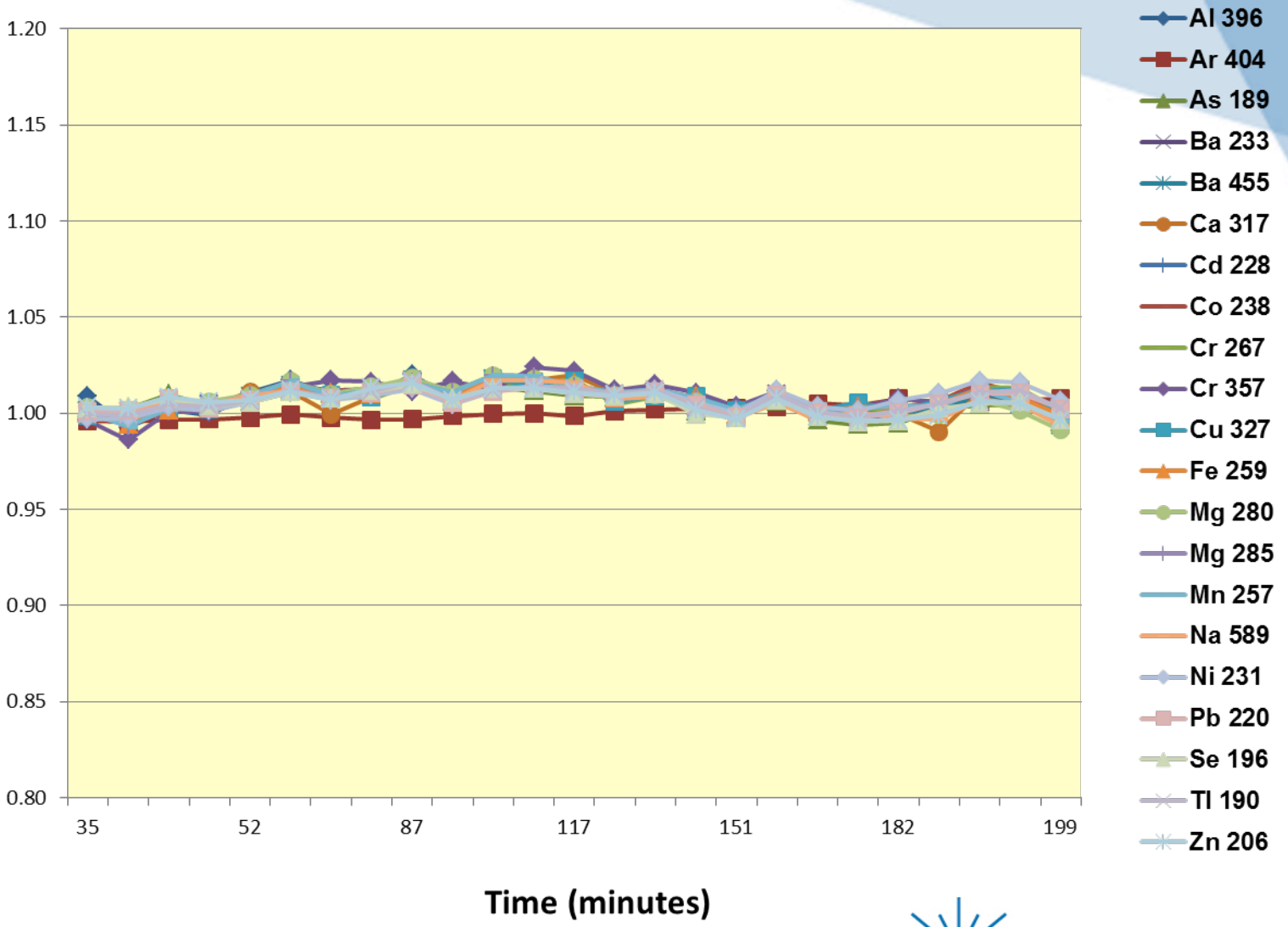
# DuraMist Long-term Stability

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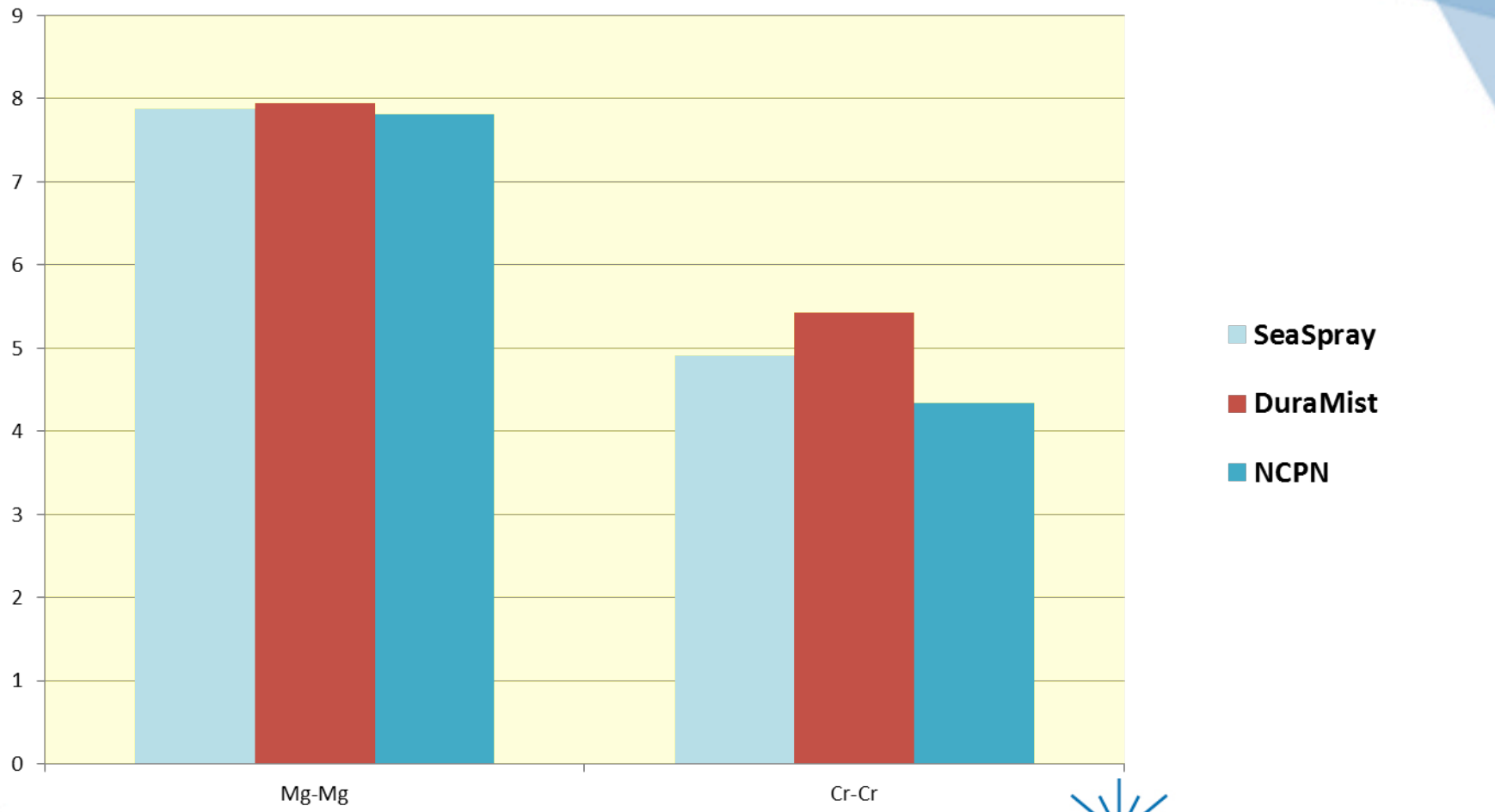
# ICP Figures of Merit

| Abbreviation | Test | Diagnostic |
|---|---|---|
| Mg-Mg | Mg280(II)/Mg285(I) | Robustness |
| Cr-Cr | Cr267(II)/Cr357(I) | Atomization/ionization |
| Zn-Ba | Zn206(II)/Ba455(II) | Excitation |
| Mg | Mg285 (I) RSD | Neb. Efficiency |
| Ar | Ar404 (I) RSD | Stability |
| Zn | Zn206 (II) RSD | Stability |
| Ba | Ba455 (II) RSD | Stability |

**Simple experiments for the control, the evaluation and the diagnosis of Inductively coupled plasma sequential systems**
E. POUSSEL and J. M. MERMET
Spectrochimica Acta, 1993

# Comparison of figures of merit

(Higher is better)

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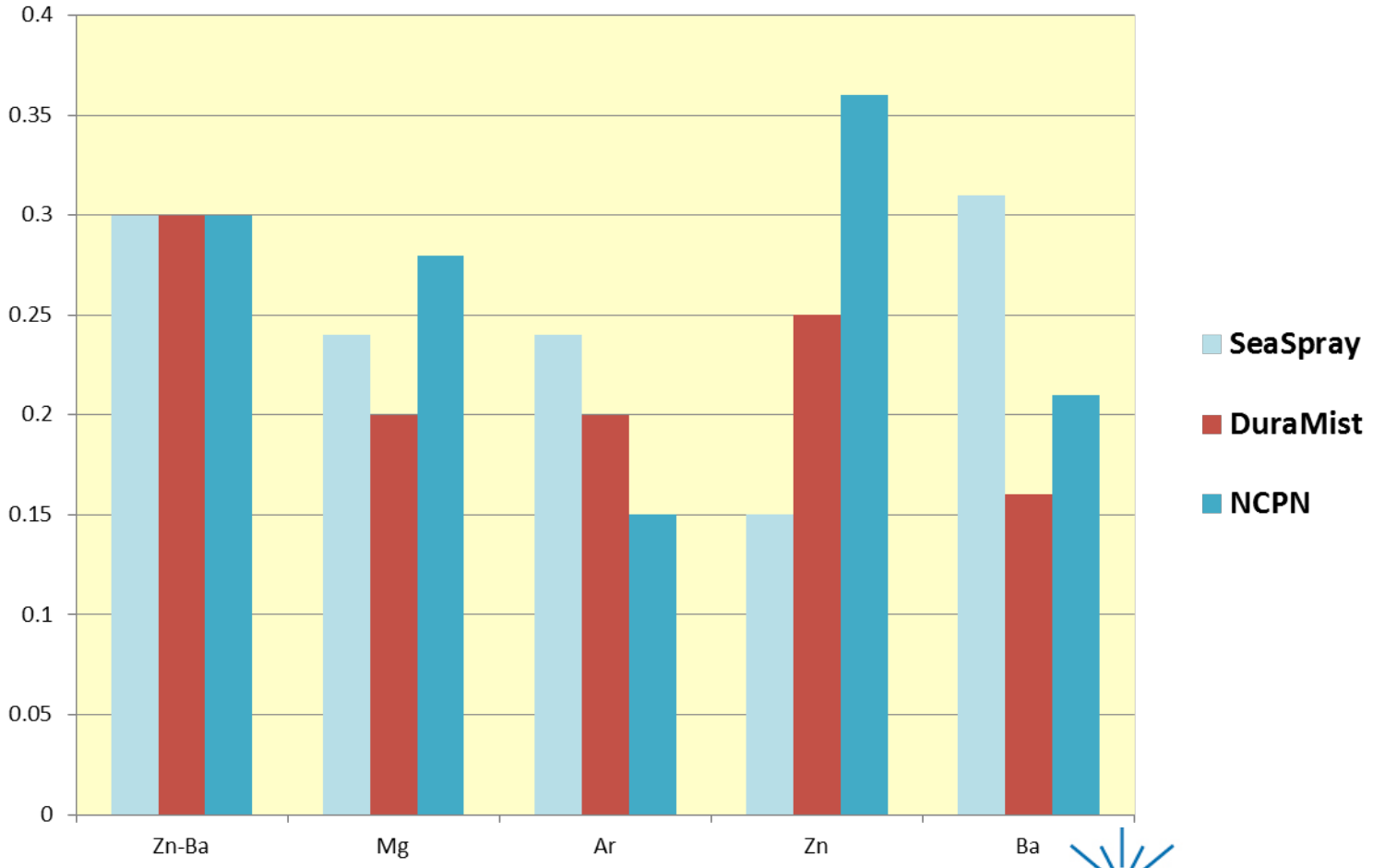
# Comparison of figures of merit
(lower is better)

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# Comparison with other inert nebulizers

## PE Optima 2100 Operating Conditions

| | |
|---|---|
| RF Power | 1400 W |
| Plasma gas | 15 L/min |
| Aux gas | 0.2 L/min |
| Neb gas | 0.65 L/min |
| Read delay time | 15 sec |
| Replicates | 3 |
| Min Integration | 1 sec |
| Max Integration | 10 sec |
| Source Equilibration delay | 15 sec |
| Plasma View | Axial (Na_589 = radial) |

IsoMist 21° C twister spray chamber, D-Torch

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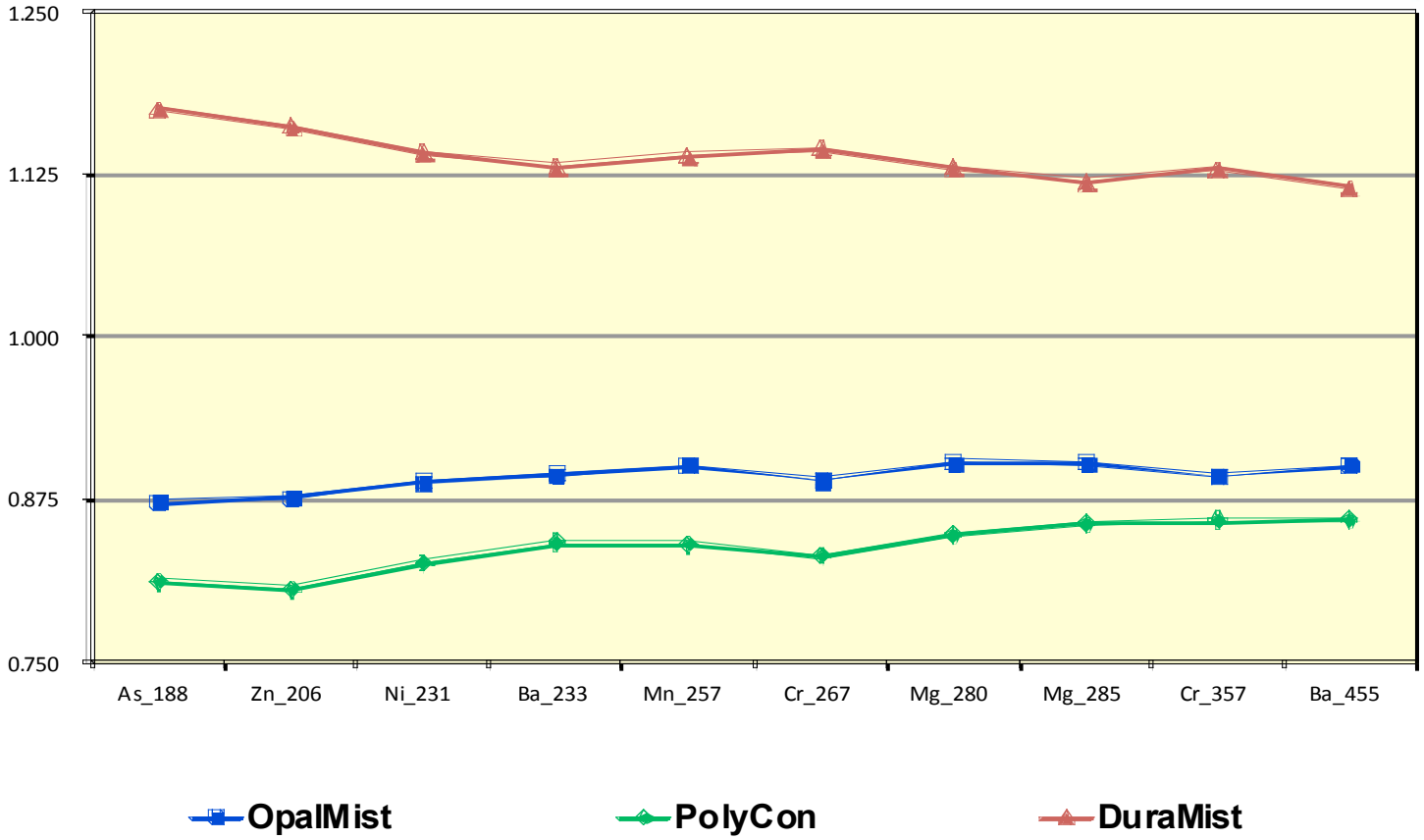
# Comparison of Sensitivity

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# Tolerance to Dissolved Salts (20%)

- Natural aspiration of 20 % NaCl.
- Nebulizer argon flow monitored at constant pressure
- Total time of 20 minutes.

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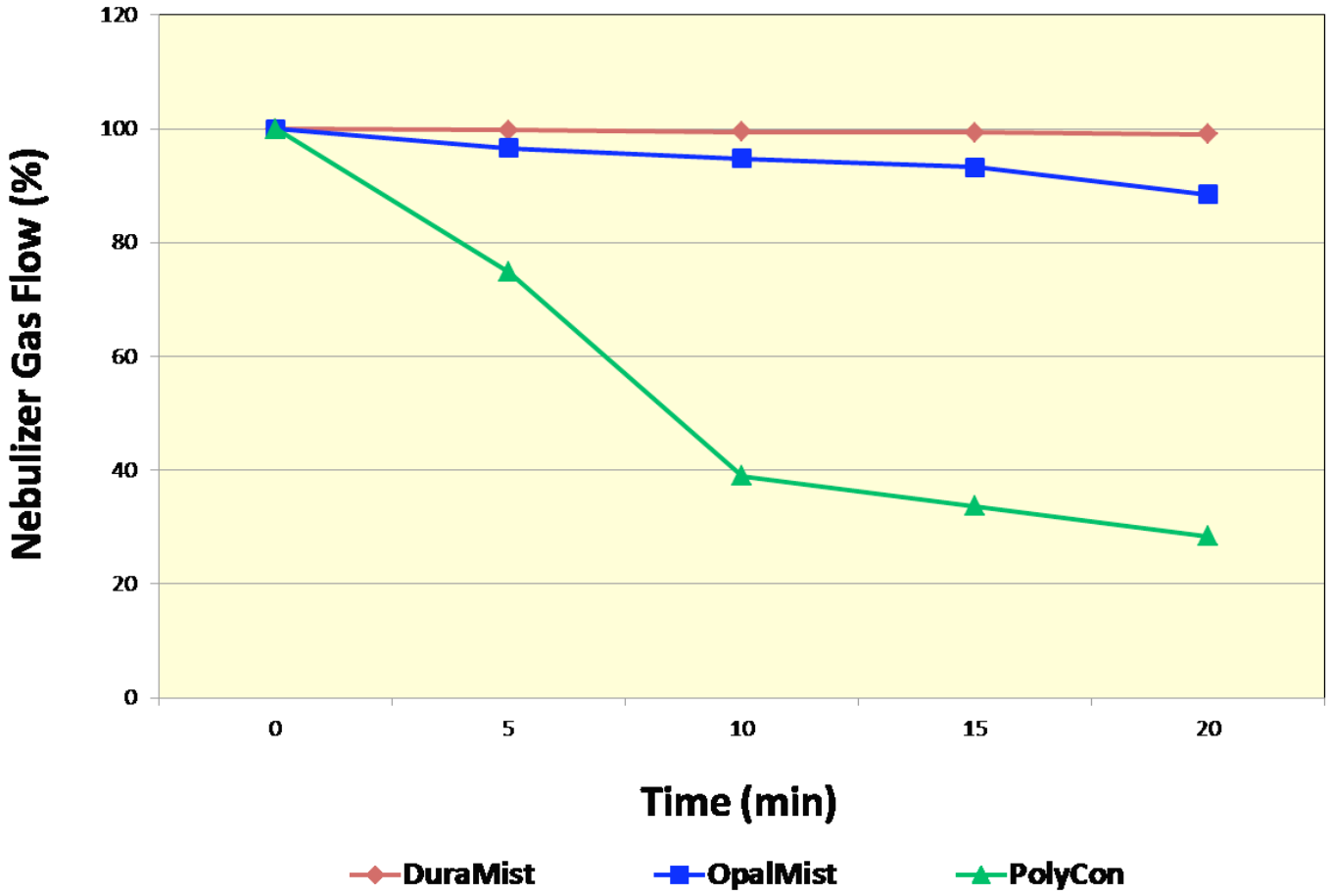
# Tolerance to Dissolved Salts (20%)

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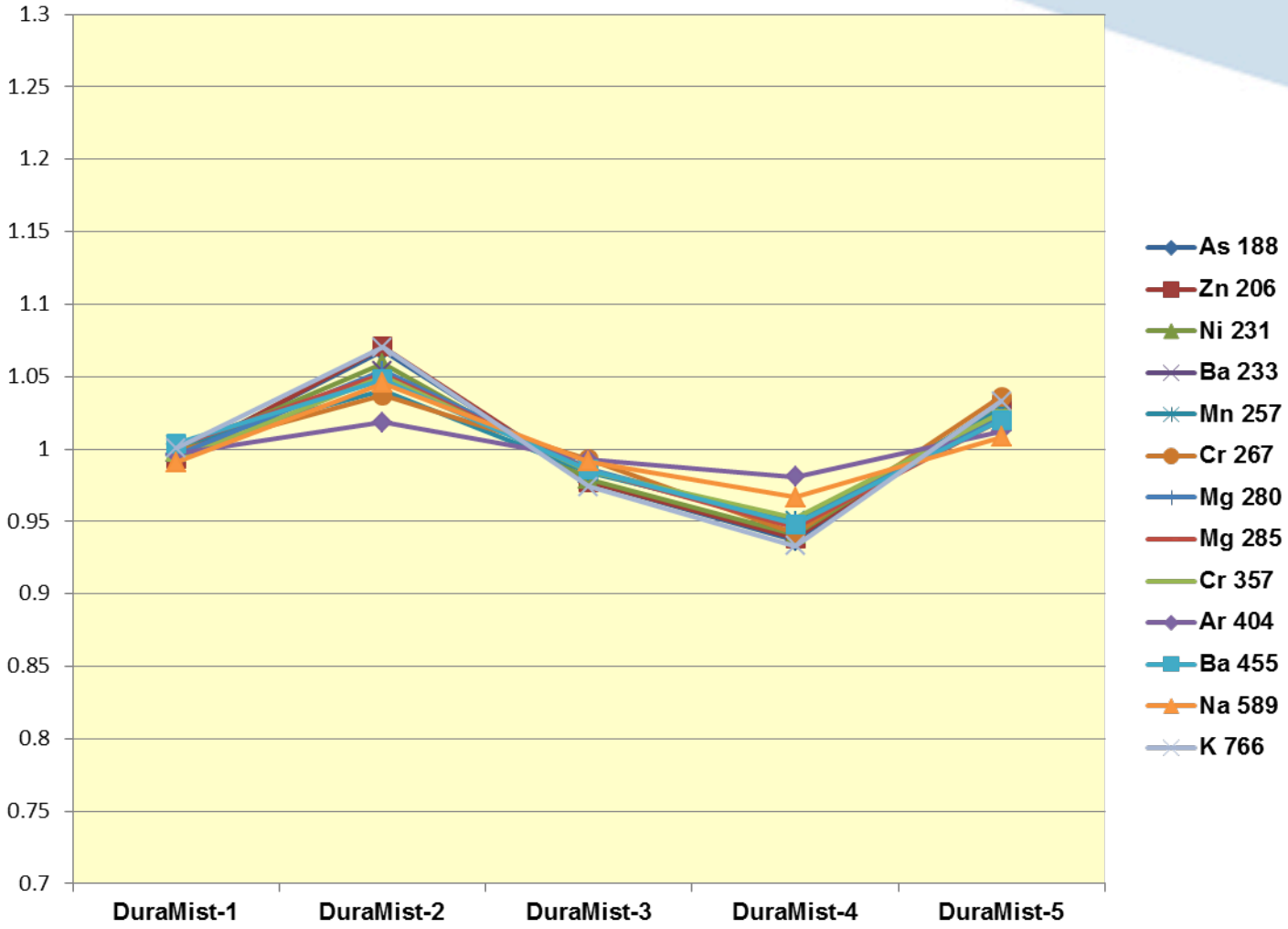
# DuraMist Reproducibility

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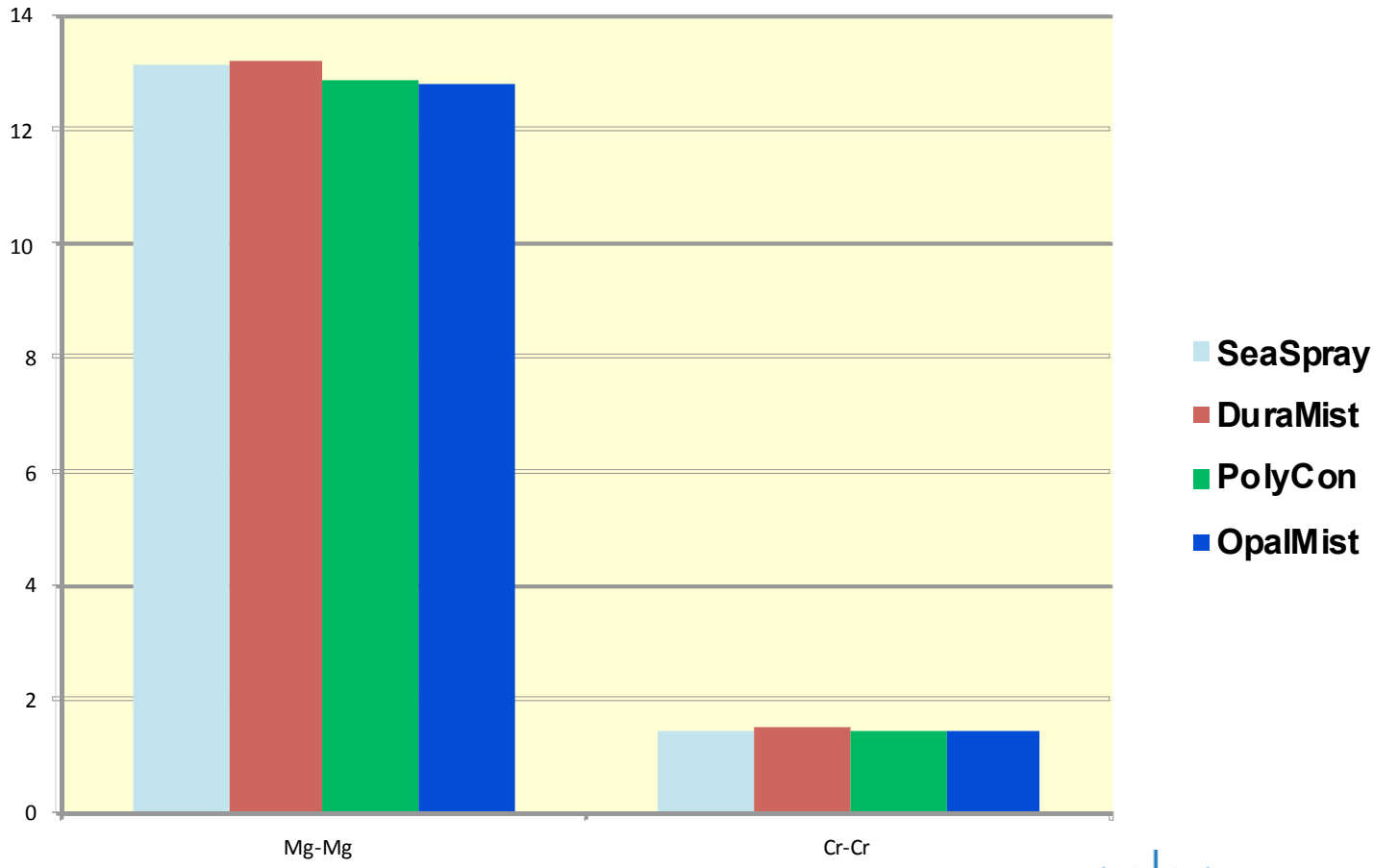


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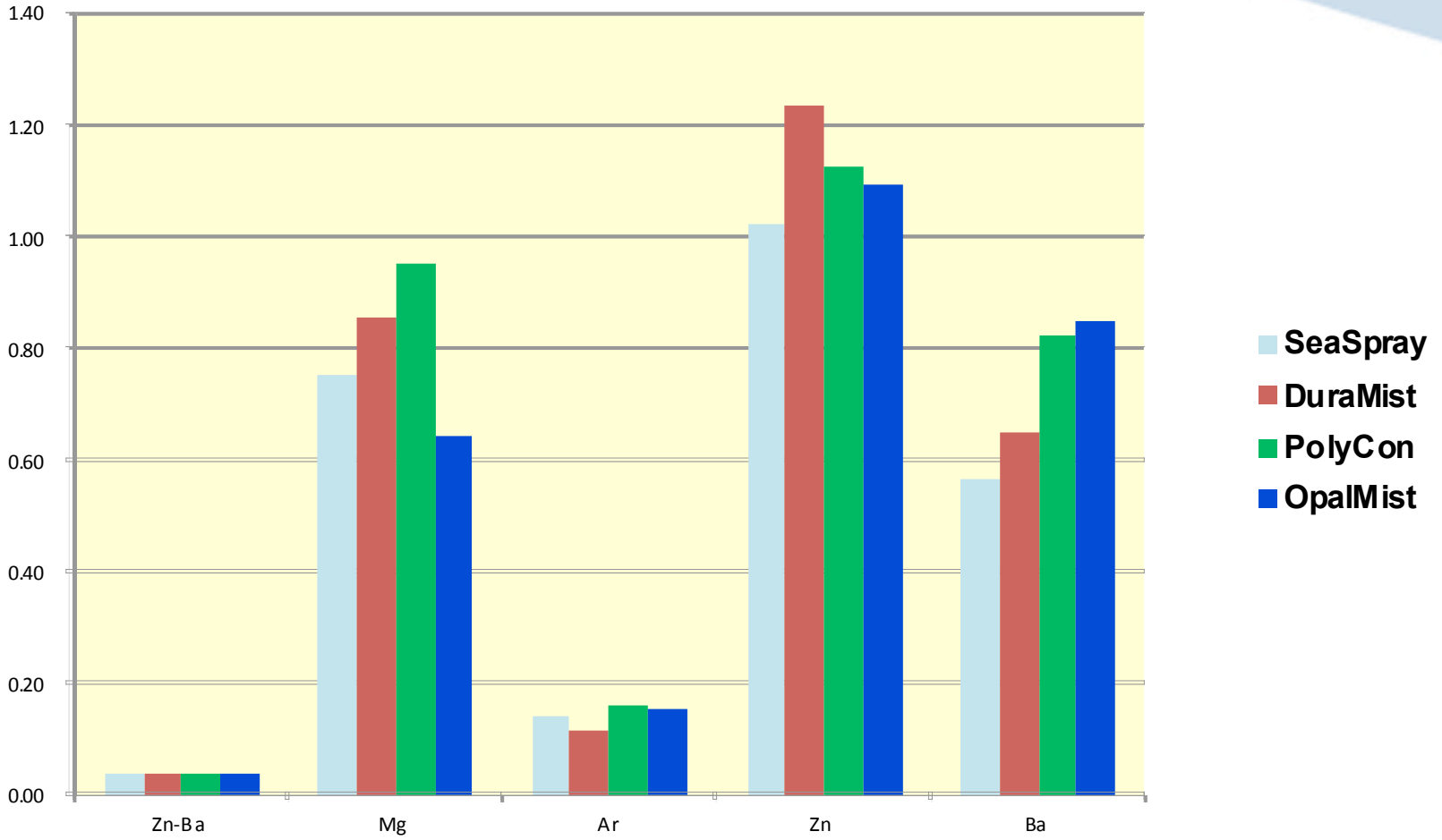


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# DuraMist Summary

- Intensities approach the best concentric glass nebulizer – the SeaSpray
- Excellent precision
- HF resistant
- Durable
- Cost effective

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