



## SPECTROMAXx LMx10

# The Analysis of Silver and its Alloys

### Introduction

The SPECTROMAXx enables the accurate analysis of silver and its alloys. The instrument takes advantage of modern CMOS technology combined with the latest generation of readout electronics. The innovative optical system covers the entire usable wavelength range to enable selection of the best analytical wavelengths paired with reference lines for evaluation.

With outstanding repeatability, reproducibility, and reliability, SPECTROMAXx is perhaps the industry's best-selling arc/spark optical emission spectrometry (OES) analyzer. Its fast, accurate, cost-effective measurements add certainty to critical supply chains.

Users get ultrafast information on changing process conditions. Also drastically reduced cost of ownership — with lower consumables, plus advanced diagnostics and easy maintenance to prevent expensive downtime. And this tenth-generation SPECTROMAXx responds to evolving plant requirements with a host of new improvements.



### Instrumentation

#### SPECTROMAXx Features

##### Optical Systems Optic I:

- Wavelength range 120 nm – 235 nm
- Focal length 300 mm. Holographic grating with 3600 gr. / mm
- CMOS detectors

##### Optic II:

- Wavelength range 233 nm – 670 nm (optional -766 nm)
- Focal length 400 mm, Holographic grating 2400 gr. / mm
- CMOS detectors

The applicable and configured wavelength range is based on the customer's application requirements. Both optics are temperature stabilized and pressure compensated.

##### Plasma Generator:

The benefit of this full digitalization with high fidelity is the guarantee that the spark pulse created is the spark pulse desired, every time.

Precision is improved and so is the similarity of the generated spark signals (unit uniformity). With our off-line digital control, we ensure that each plasma generator delivers identical spark signals, with a negligible deviation between any two plasma generators.

Every plasma generator has a programmable output power waveform for application specific optimization.

**Online drift correction and background correction:**

- Permanent control of the peak position of each line and readjustment if needed (iCAL 2.0)
- Recalculation of the background signal wherever it is possible

**Optimized Measurement Times:**

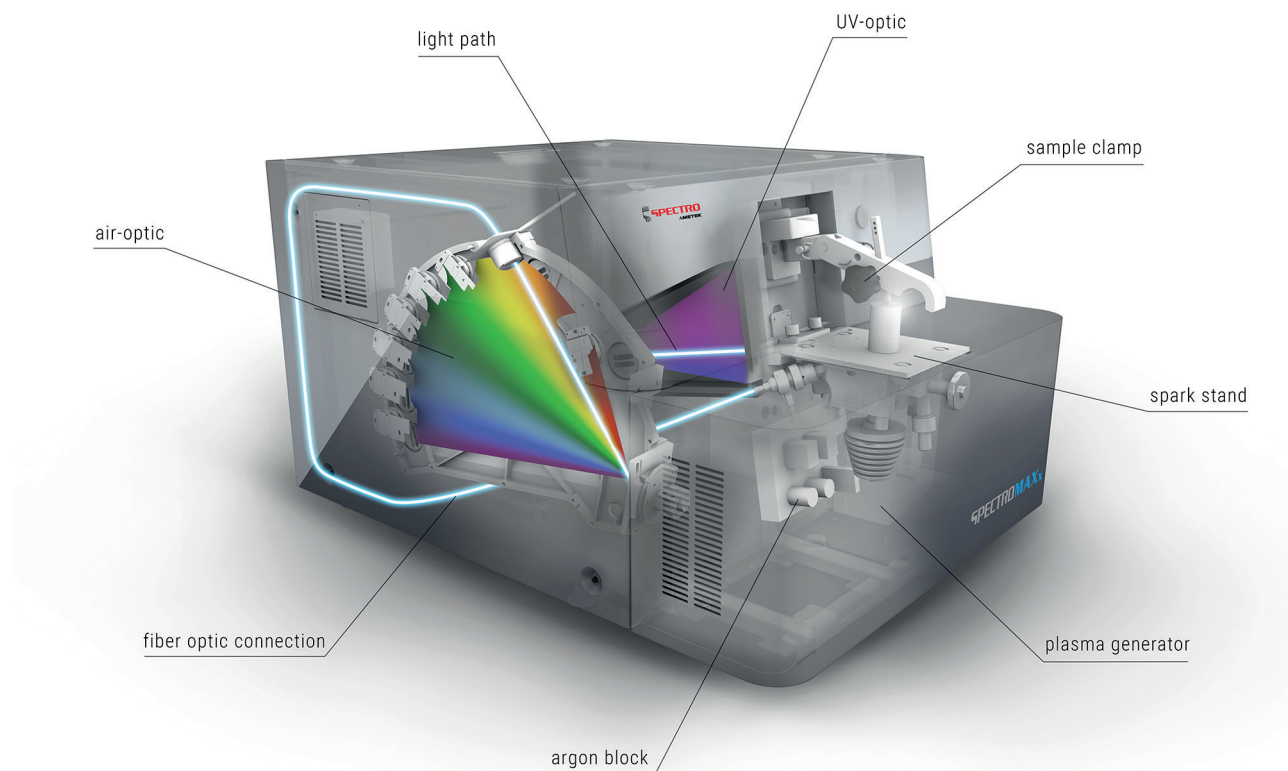
- Dynamic pre-burn time, reflecting the sample quality
- Minimized delay between measurement sequences
- Optimized number of excitation parameters including frequencies of up to 1000 Hz

**Intelligent Calibration Logic (iCAL 2.0):**

- Profile position control and standardization with only one sample

**Accuracy of Analysis**

It is the aim of modern OES spectrometers to greatly reduce the influence of the structure and composition (matrix) effects. The SPECTROMAXx combines traditional technologies like HEPS-High Energy Pre Spark to reach the stationary phase by “remelting” a small portion of the sample, resulting in a reduced structure effect.



**Table 1: Calculation of detection limit (DL) according to DIN 32645:2008-11 with a confidence limit of 99.7% (3 sigma), recorded on a production series device.**

| Element               | Cu         | Al              | As              | Au           | Bi           | Cd           | Fe             | Mg             |
|-----------------------|------------|-----------------|-----------------|--------------|--------------|--------------|----------------|----------------|
| Calibration range (%) | 0.0002 -23 | 0.0001 - 0.0015 | 0.0001 - 0.0210 | 0.0005 - 1.0 | 0.0005 - 0.2 | 0.0001 - 0.1 | 0.0001 - 0.025 | 0.0001 - 0.010 |
| Detection Limit (ppm) | 2          | 1               | 1               | 5            | 5            | 1            | 1              | 1              |

| Element               | Mn             | Ni             | Pb             | Pd             | Pt             | Sb             | Se             | Sn           |
|-----------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|--------------|
| Calibration range (%) | 0.0002 - 0.011 | 0.0010 - 0.225 | 0.0002 - 0.500 | 0.0010 - 0.021 | 0.0001 - 0.020 | 0.0005 - 0.020 | 0.0001 - 0.170 | 0.0001 - 0.2 |
| Detection Limit (ppm) | 2              | 10             | 2              | 10             | 1              | 5              | 1              | 1            |

| Element               | Te           | Zn             |
|-----------------------|--------------|----------------|
| Calibration range (%) | 0.0002 - 2.0 | 0.0001 - 0.260 |
| Detection Limit (ppm) | 2            | 1              |

**Table 2: Sample 1      Ag-Global**

| Element | Cu     | Al      | As      | Au    | Bi      | Cd     | Fe     | Mg      |
|---------|--------|---------|---------|-------|---------|--------|--------|---------|
| 1       | 5.80   | 0.00059 | 0.00088 | 0.982 | <0.0005 | 0.0013 | 0.0030 | 0.00022 |
| 2       | 5.73   | 0.00058 | 0.00086 | 0.978 | <0.0005 | 0.0014 | 0.0036 | 0.00030 |
| 3       | 5.83   | 0.00059 | 0.00096 | 0.976 | <0.0005 | 0.0014 | 0.0030 | 0.00023 |
| 4       | 5.78   | 0.0006  | 0.00098 | 0.975 | <0.0005 | 0.0013 | 0.0035 | 0.00021 |
| <x>     | 5.79   | 0.00059 | 0.00092 | 0.978 | <0.0005 | 0.0014 | 0.0033 | 0.00024 |
| SD      | 0.0431 |         |         | 0.003 |         |        |        |         |

| Element | Mn      | Ni     | Pb     | Pd     | Pt     | Sb      | Se      | Sn      |
|---------|---------|--------|--------|--------|--------|---------|---------|---------|
| 1       | <0.0002 | 0.0015 | 0.473  | 0.0029 | 0.0033 | 0.0307  | 0.00066 | 0.00041 |
| 2       | <0.0002 | 0.0018 | 0.466  | 0.0030 | 0.0034 | 0.0313  | 0.00062 | 0.00043 |
| 3       | <0.0002 | 0.0017 | 0.475  | 0.0025 | 0.0033 | 0.0311  | 0.00079 | 0.00029 |
| 4       | <0.0002 | 0.0013 | 0.470  | 0.0027 | 0.0034 | 0.0301  | 0.00073 | 0.00041 |
| <x>     | <0.0002 | 0.0016 | 0.471  | 0.0028 | 0.0034 | 0.0308  | 0.0007  | 0.00038 |
| SD      |         |        | 0.0037 |        |        | 0.00053 | 0.00007 |         |

| Element | Te      | Zn     | Ag     |
|---------|---------|--------|--------|
| 1       | 0.0086  | 0.0019 | 92.69  |
| 2       | 0.0081  | 0.0019 | 92.77  |
| 3       | 0.0089  | 0.0019 | 92.66  |
| 4       | 0.0083  | 0.0019 | 92.72  |
| <x>     | 0.0085  | 0.0019 | 92.71  |
| SD      | 0.00035 |        | 0.0467 |

**Table 3: Sample 2 Ag-Global**

| Element | Cu     | Al      | As      | Au      | Bi      | Cd      | Fe      | Mg      |
|---------|--------|---------|---------|---------|---------|---------|---------|---------|
| 1       | 0.141  | <0.0001 | <0.0001 | 0.0021  | <0.0005 | 0.00110 | <0.0001 | 0.00026 |
| 2       | 0.125  | <0.0001 | <0.0001 | 0.0024  | <0.0005 | 0.00096 | <0.0001 | 0.00013 |
| 3       | 0.135  | <0.0001 | <0.0001 | 0.0014  | 0.00057 | 0.00140 | <0.0001 | 0.00025 |
| <x>     | 0.134  | <0.0001 | <0.0001 | 0.002   | 0.00052 | 0.0011  | <0.0001 | 0.00021 |
| SD      | 0.0081 |         |         | 0.00047 | 0.00004 | 0.00022 |         | 0.00007 |

| Element | Mn      | Ni      | Pb      | Pd      | Pt      | Sb      | Se      | Sn      |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1       | <0.0002 | <0.0010 | 0.00091 | <0.0010 | 0.00020 | 0.00060 | <0.0001 | 0.0014  |
| 2       | <0.0002 | <0.0010 | 0.00053 | 0.0012  | 0.00022 | <0.0005 | <0.0001 | 0.0013  |
| 3       | <0.0002 | <0.0010 | 0.00100 | <0.0010 | 0.00028 | 0.00073 | 0.00049 | 0.0014  |
| <x>     | <0.0002 | <0.0010 | 0.00083 | 0.0011  | 0.00023 | 0.00061 | 0.00023 | 0.0014  |
| SD      |         |         | 0.00026 | 0.00011 | 0.00004 | 0.00011 | 0.00023 | 0.00005 |

| Element | Te      | Zn      | Ag     |
|---------|---------|---------|--------|
| 1       | 0.00032 | 0.0014  | 99.85  |
| 2       | <0.0002 | 0.0013  | 99.86  |
| 3       | 0.00074 | 0.0016  | 99.85  |
| <x>     | 0.00042 | 0.0014  | 99.85  |
| SD      | 0.00028 | 0.00017 | 0.0085 |

**Table 4: Sample 3 Ag-Global**

| Element | Cu      | Al      | As      | Au      | Bi      | Cd      | Fe      | Mg      |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1       | 0.0149  | <0.0001 | <0.0001 | <0.0005 | <0.0005 | <0.0001 | <0.0001 | 0.00032 |
| 2       | 0.0155  | <0.0001 | <0.0001 | <0.0005 | <0.0005 | <0.0001 | <0.0001 | 0.00029 |
| 3       | 0.0141  | <0.0001 | <0.0001 | <0.0005 | <0.0005 | <0.0001 | <0.0001 | 0.00038 |
| 4       | 0.0143  | <0.0001 | <0.0001 | <0.0005 | <0.0005 | <0.0001 | 0.0001  | 0.00033 |
| <x>     | 0.0147  | <0.0001 | <0.0001 | <0.0005 | <0.0005 | <0.0001 | 0.0001  | 0.00033 |
| SD      | 0.00062 |         |         |         |         |         |         |         |

| Element | Mn       | Ni       | Pb     | Pd      | Pt      | Sb      | Se      | Sn      |
|---------|----------|----------|--------|---------|---------|---------|---------|---------|
| 1       | 0.00041  | <0.00100 | 0.0052 | 0.0011  | 0.00016 | <0.0005 | <0.0001 | <0.0001 |
| 2       | <0.0002  | <0.00100 | 0.0029 | 0.0011  | <0.0001 | <0.0005 | <0.0001 | <0.0001 |
| 3       | <0.00020 | <0.00100 | 0.003  | 0.0011  | 0.00015 | <0.0005 | <0.0001 | <0.0001 |
| 4       | <0.0002  | <0.00100 | 0.0028 | <0.0010 | <0.0001 | <0.0005 | <0.0001 | <0.0001 |
| <x>     | 0.00025  | <0.00100 | 0.0035 | 0.0011  | 0.00013 | <0.0005 | <0.0001 | <0.0001 |
| SD      |          |          | 0.0011 |         |         |         |         |         |

| Element | Te      | Zn      | Ag     |
|---------|---------|---------|--------|
| 1       | 0.00140 | <0.0001 | 99.97  |
| 2       | 0.00076 | <0.0001 | 99.98  |
| 3       | 0.00160 | <0.0001 | 99.98  |
| 4       | 0.00075 | <0.0001 | 99.98  |
| <x>     | 0.00110 | <0.0001 | 99.98  |
| SD      |         |         | 0.0017 |

**Table 5: Sample 4 Ag-Global**

| Element | Cu      | Al      | As      | Au      | Bi      | Cd      | Fe      | Mg      |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1       | 0.0419  | 0.00012 | 0.0187  | 0.0188  | 0.0243  | <0.0001 | 0.00086 | 0.00032 |
| 2       | 0.0400  | 0.00010 | 0.0195  | 0.0186  | 0.0258  | <0.0001 | 0.00094 | 0.00017 |
| 3       | 0.0400  | 0.00009 | 0.0197  | 0.0186  | 0.0251  | <0.0001 | 0.00082 | 0.00011 |
| 4       | 0.0401  | 0.00009 | 0.0193  | 0.0189  | 0.0238  | <0.0001 | 0.00063 | 0.00010 |
| <x>     | 0.0405  | 0.00010 | 0.0193  | 0.0187  | 0.0247  | <0.0001 | 0.00081 | 0.00018 |
| SD      | 0.00092 |         | 0.00041 | 0.00016 | 0.00087 |         |         |         |

| Element | Mn     | Ni      | Pb      | Pd      | Pt      | Sb      | Se      | Sn      |
|---------|--------|---------|---------|---------|---------|---------|---------|---------|
| 1       | 0.0028 | 0.0072  | 0.0125  | 0.0103  | 0.0074  | 0.0098  | 0.0079  | 0.0182  |
| 2       | 0.0029 | 0.0069  | 0.0130  | 0.0101  | 0.0074  | 0.0096  | 0.0079  | 0.0180  |
| 3       | 0.0029 | 0.0075  | 0.0136  | 0.0100  | 0.0073  | 0.0095  | 0.0082  | 0.0183  |
| 4       | 0.0028 | 0.0070  | 0.0145  | 0.0100  | 0.0076  | 0.0096  | 0.0080  | 0.0181  |
| <x>     | 0.0028 | 0.0071  | 0.0134  | 0.0101  | 0.0074  | 0.0096  | 0.0080  | 0.0181  |
| SD      |        | 0.00027 | 0.00085 | 0.00012 | 0.00013 | 0.00013 | 0.00013 | 0.00013 |

| Element | Te      | Zn      | Ag      |
|---------|---------|---------|---------|
| 1       | 0.0163  | 0.0051  | 99.8    |
| 2       | 0.0169  | 0.0052  | 99.8    |
| 3       | 0.0170  | 0.0053  | 99.8    |
| 4       | 0.0162  | 0.0052  | 99.8    |
| <x>     | 0.0166  | 0.0052  | 99.8    |
| SD      | 0.00044 | 0.00008 | 0.00091 |

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SPECTRO Analytical Instruments GmbH  
 Boschstrasse 10  
 D-47533 Kleve  
 Tel. +49.2821.892.0  
[spectro.sales@ametek.com](mailto:spectro.sales@ametek.com)

**U.S.A.**

SPECTRO Analytical Instruments Inc.  
 50 Fordham Rd  
 Wilmington 01887, MA  
 Tel. +1 800 548 5809  
 +1 201 642 3000  
[spectro-usa.sales@ametek.com](mailto:spectro-usa.sales@ametek.com)

**CHINA**

AMETEK Commercial  
 Enterprise (Shanghai) CO., LTD.  
 Part A1, A4 2nd Floor Building No. 1 Plot Section  
 No. 526 Fute 3rd Road East; Pilot Free Trade Zone  
 200131 Shanghai  
 Tel. +86.400.022.7699  
[spectro-china.sales@ametek.com](mailto:spectro-china.sales@ametek.com)

**Subsidiaries:**

► **FRANCE:** Tel. +33.1.3068.8970, [spectro-france.sales@ametek.com](mailto:spectro-france.sales@ametek.com) ► **GREAT BRITAIN:** Tel. +44.1162.462.950, [spectro-uk.sales@ametek.com](mailto:spectro-uk.sales@ametek.com)  
 ► **INDIA:** Tel. +91.22.6196.8200, [sales.spectroindia@ametek.com](mailto:sales.spectroindia@ametek.com) ► **ITALY:** Tel. +39.02.94693.1, [spectro-italy.sales@ametek.com](mailto:spectro-italy.sales@ametek.com)  
 ► **JAPAN:** Tel. +81.3.6809.2405, [spectro-japan.info@ametek.co.jp](mailto:spectro-japan.info@ametek.co.jp) ► **SOUTH AFRICA:** Tel. +27.11.979.4241, [spectro-za.sales@ametek.com](mailto:spectro-za.sales@ametek.com)

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