WEBINAR 2021

How to Achieve Significant Cost Reduction in Polymer Production

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How to Achieve Significant Cost Reduction in Polymer Production

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Ph D of Analytical Chemistry, Hamburg

2001 Method Development Bruker AXS

Now Head of Product Management XRF

Karlsruhe, Germany

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Chemical Engineer (Dipl. FH)

2012 Product Management Bruker AXS

Product Management XRF

Karlsruhe, Germany

Outline

01 Backgrounds on Polymers and Plastics

02 Sample Preparation

03 Analytical Technology

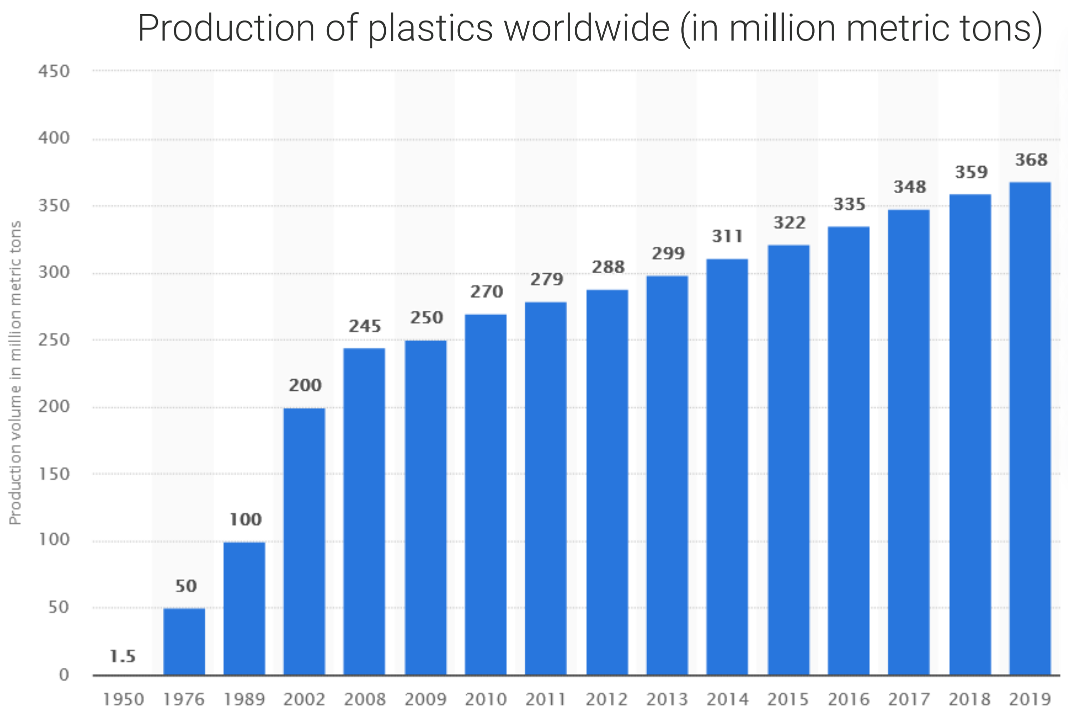
04 Compact EDXRF for Polymers

05 Mid power WDXRF for flexibility

06 Multi-Purpose instrumentation

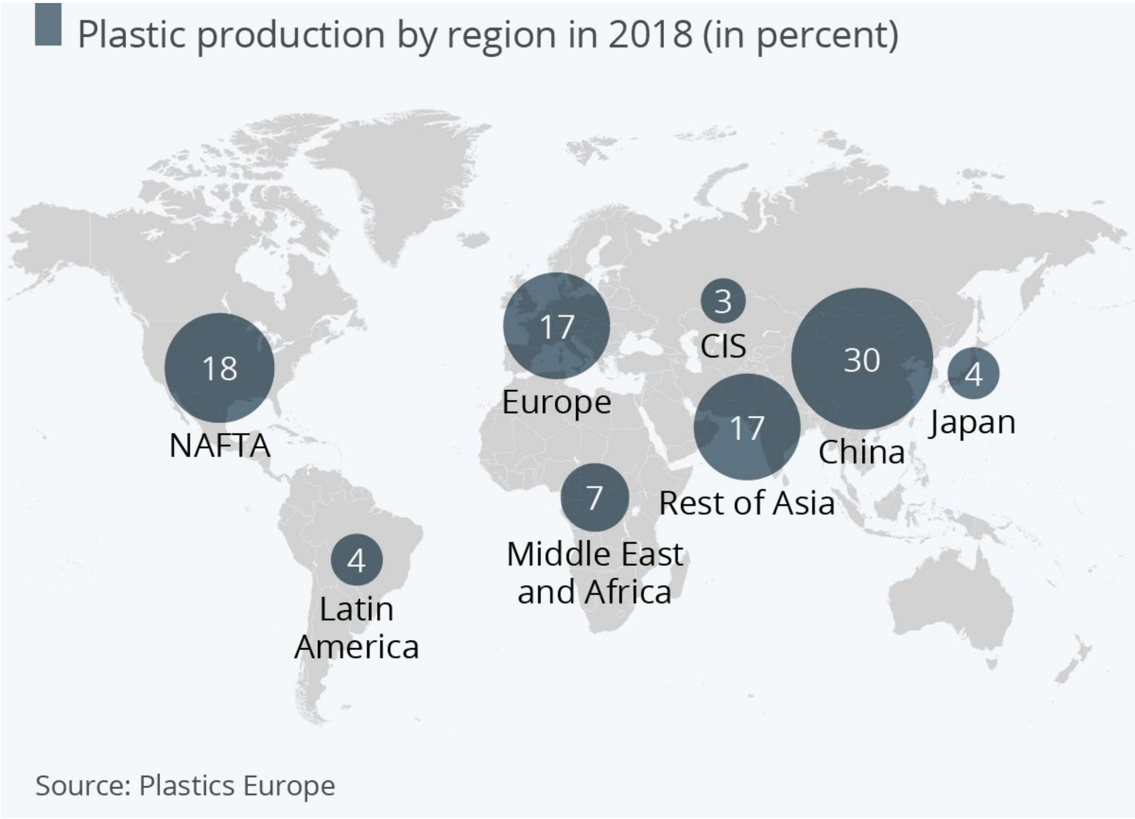
07 Conclusion

Changing everyday products, develop the world – with Polymers



- PE, PP, PVC and PS are very popular polymers and have replaced a lot of traditional materials, such as metal or wood, due to longer lifetime and lower weight, better shaping and coloring characteristics at lower costs
- ABS, PET and Teflon are replacing other materials, such as ceramics and glass, in technologically advanced products
- Polymers and plastics have made a lot of products available for everybody at lower costs
  - Household appliances
  - Electronics/Entertainment equipment
  - Toys, clothes, shoes

Why to be in Plastics Markets?

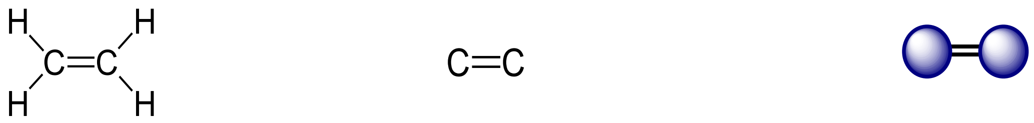


- The production of the majority of polymers is mainly linked to oil production and refineries -> the gas fraction is the source for PE and PP
- The biggest share is now in Asia (Middle East and China) -> Asia produces half the plastic of the world
- US and Europe are falling behind due to major shift of production to Asia
  - Specialty products still being made in US/EU

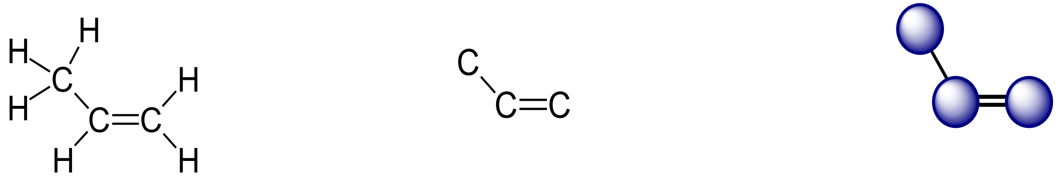
Typical Building Blocks (Monomers)

- Monomers are main products of refineries, linked to polymer producers:

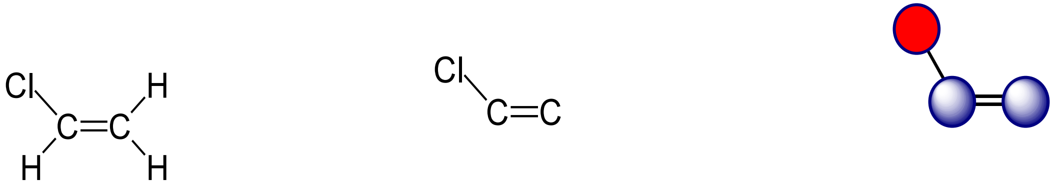
Ethylene



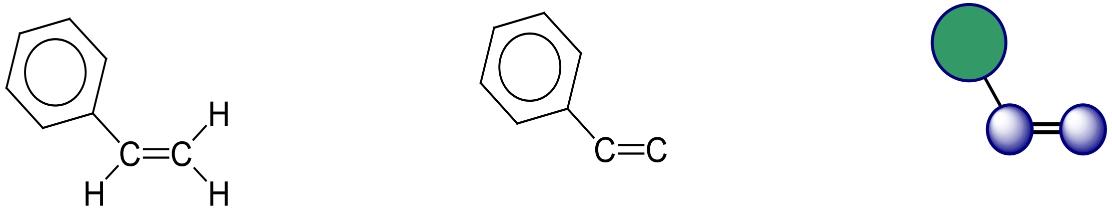
Propylene



Vinyl chloride



Styrene



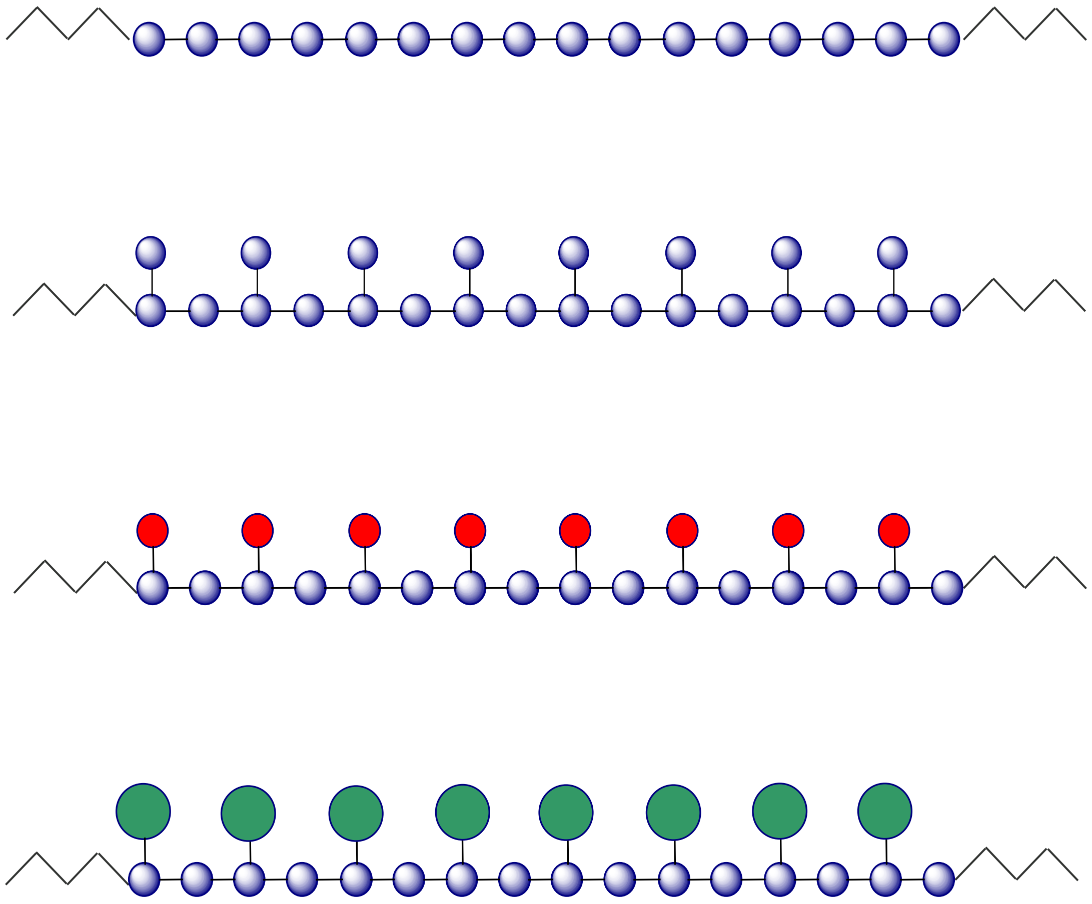
The respective Homopolymers

- Important: Poly(ethylene) (PE)

  Poly(propylene) (PP)

  Poly(vinylchloride) PVC

  Poly(styrene) (PS)



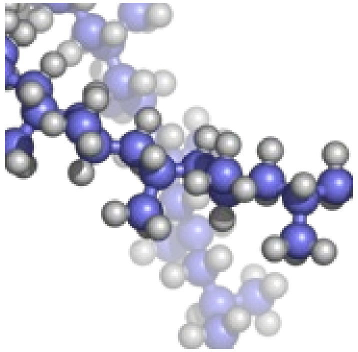
Polymers

The pure polymer is expensive and will not withstand the conditions the final product is exposed to.

- Additives
- Catalysts Residues
- Impurities
- Toxic and regulated elements

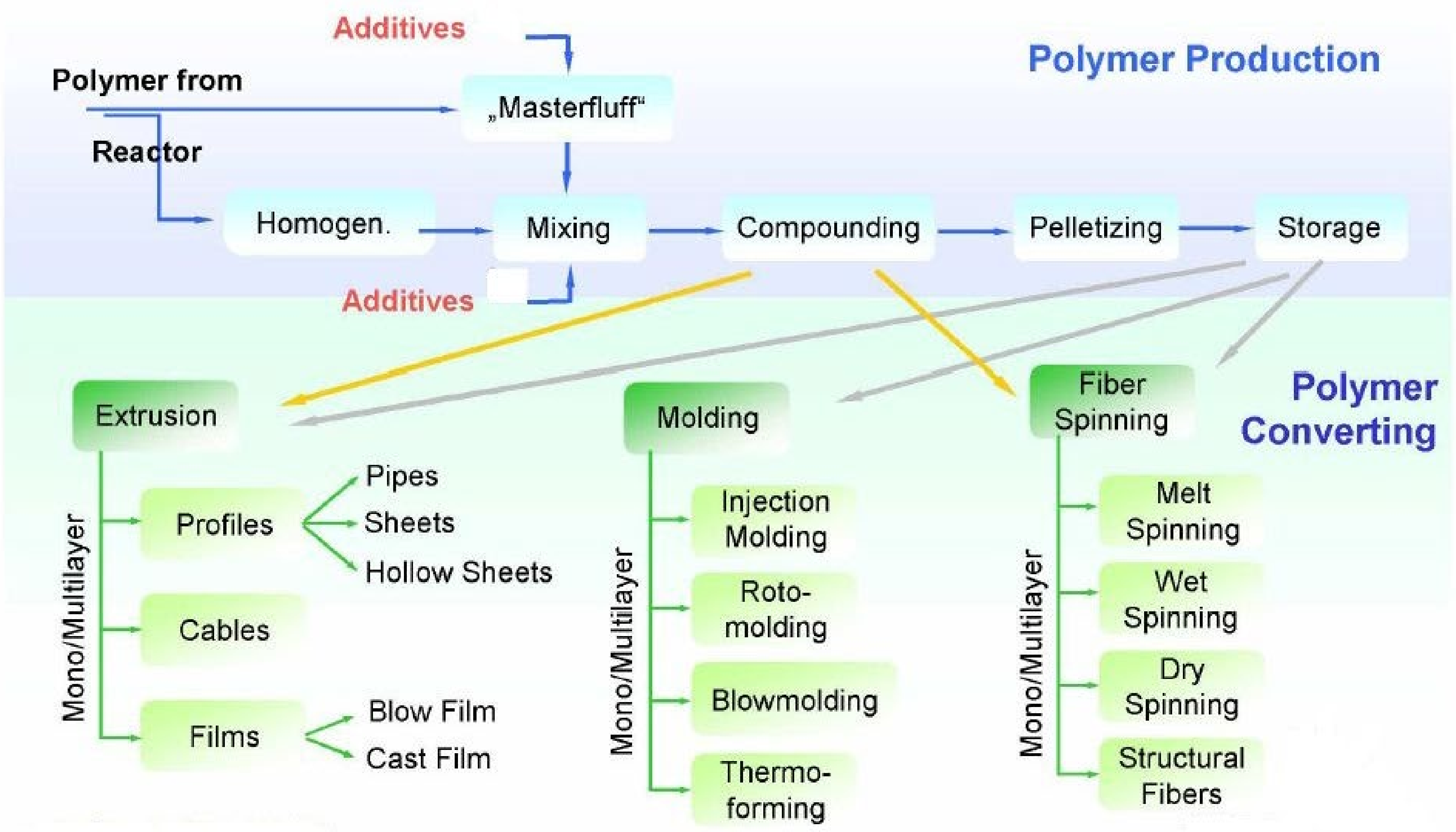
- are influencing durability, quality, product characteristic, efficient production






The element concentrations determine the final product quality, therefore the product value for the later use!

Processing Chain / Workflow



Additives
Make Polymers fit for Purpose

Typical additives:

- Thermal stabilizers (processing, long term)
- UV stabilizers
- Pigments
- Carbon black
- Processing aids
- Anti-block
- Anti-statics
- Slip agents
- Flame retardant

Characteristics

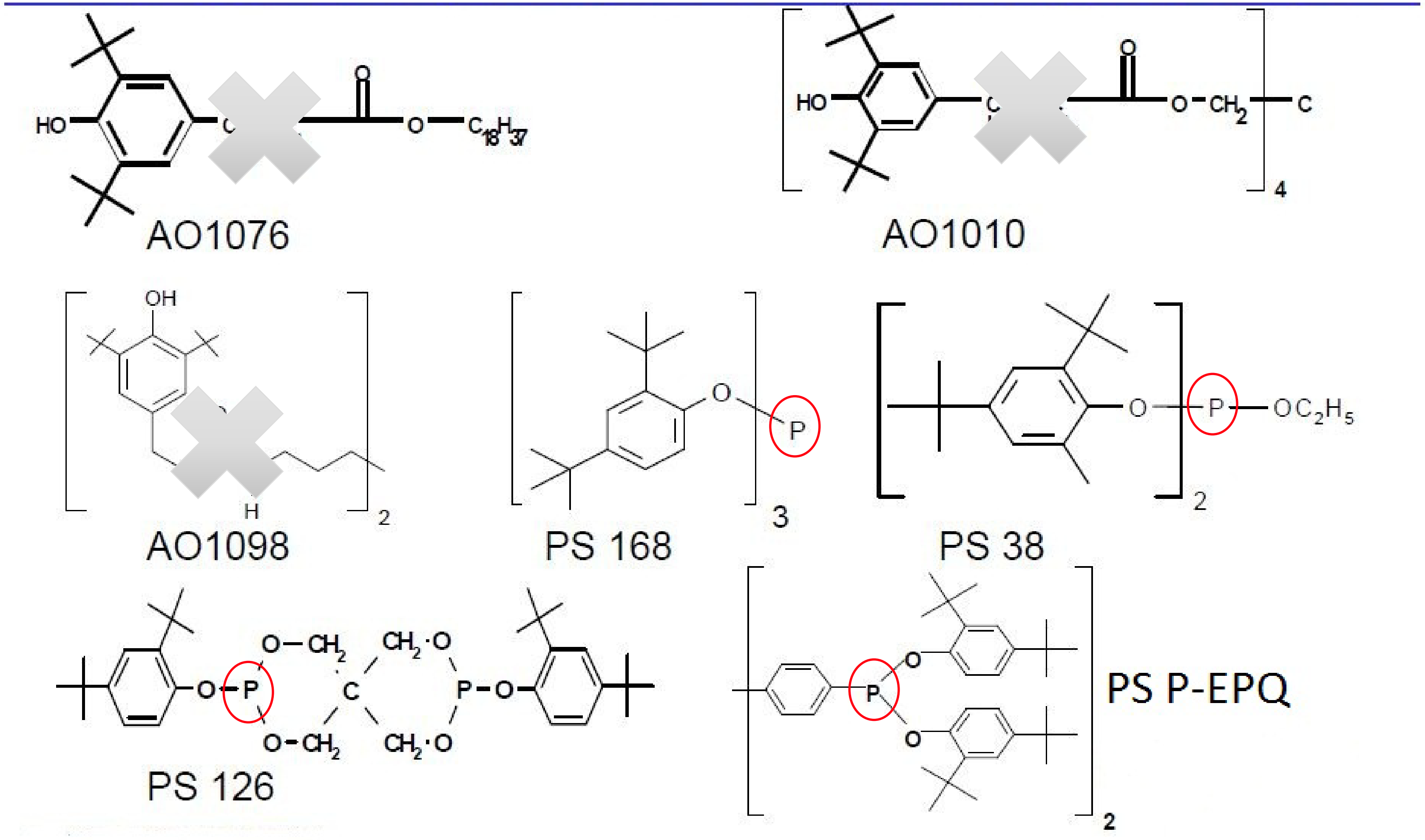
- Durability
- Colors
- Protection

Plastics are a main source of environmental pollution, but it is not that easy:

- Polymer packaging are helping to extend the storage life of food products ensuring longer shelf life, lower wasting of food

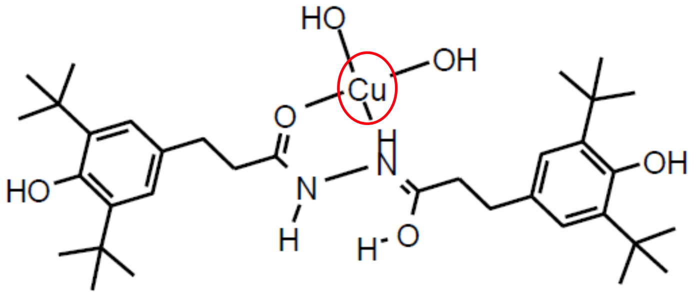
Chemical Structures of Main Antioxidants

- Exposing a polymer to sunlight and air/water/heat will lead to decay
- Polymers need to be stabilized and protected versus early aging
- Expensive and partially hazardous substances are used

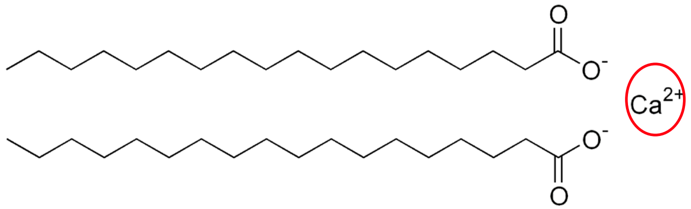


Stabilizer and Processing Aids

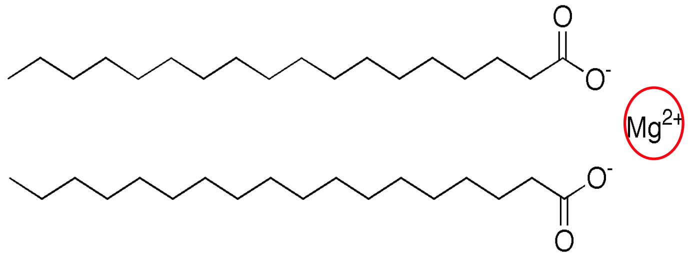
- Metal deactivators form stable complexes with metal ions thus improving stability



- Calciumstearate



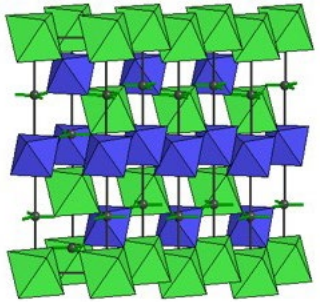
- Magnesiumstearate

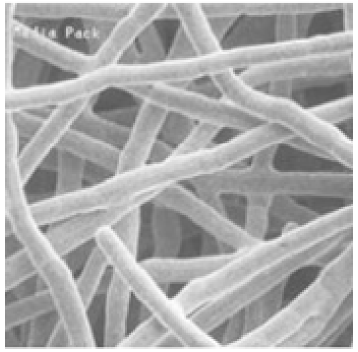


Fillers

- Polymer itself is too expensive
- Fillers are used to dilute
- And to modify

- Talc ($Mg_3Si_4O_{10}(OH)_2$)
- Dolomite ($(CaMg)(CO_3)_2$)
- Magnesite ($MgCO_3$)
- Conductive fillers
  - Stainless steel fibers
  - Coated mica
  - Glas fibers
  - Aluminum flakes
  - Tracer





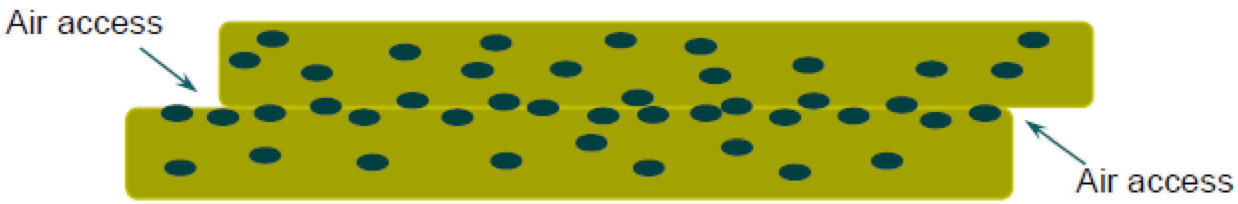
Pigments

Coloring of polymers

- Ultramarine Blue $Na_{8-x}[(Al,Si)_{12}]O_{24}(Sy)_2$
- Red Iron Oxides (Fe_2O_3)
- Yellow Iron Oxides (FeOOH)
- Black Iron Oxides (Fe_3O_4)
- Brown Iron Oxides (Fe_2O_3, FeOOH, Fe_4O_4)
- Chrome Yellows ($PbCrO_4.PbSO_4$)

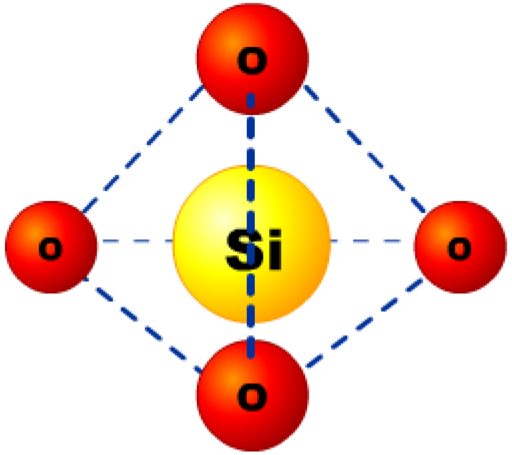
Anti-blocking Agents

Antiblocking = air buffer build-up between films



In principal inorganic particles are used:

- Silica (SiO_2)
- Talc ($Mg_3Si_4O_{10}(OH)_2$)



How does current Polymer Analysis often looks like?

Atomic Absorption Spectrometry (AAS)

- Sample must be prepared/**digested**/diluted
- Requires daily instrument calibration
- Requires gases for flame or graphite tubes
- Usually, single element analysis

Inductively Coupled Plasma Spectrometry (ICP-OES)

- Similar to AAS
- Requires expensive Argon gas for plasma
- Requires adjustment of plasma gas conditions

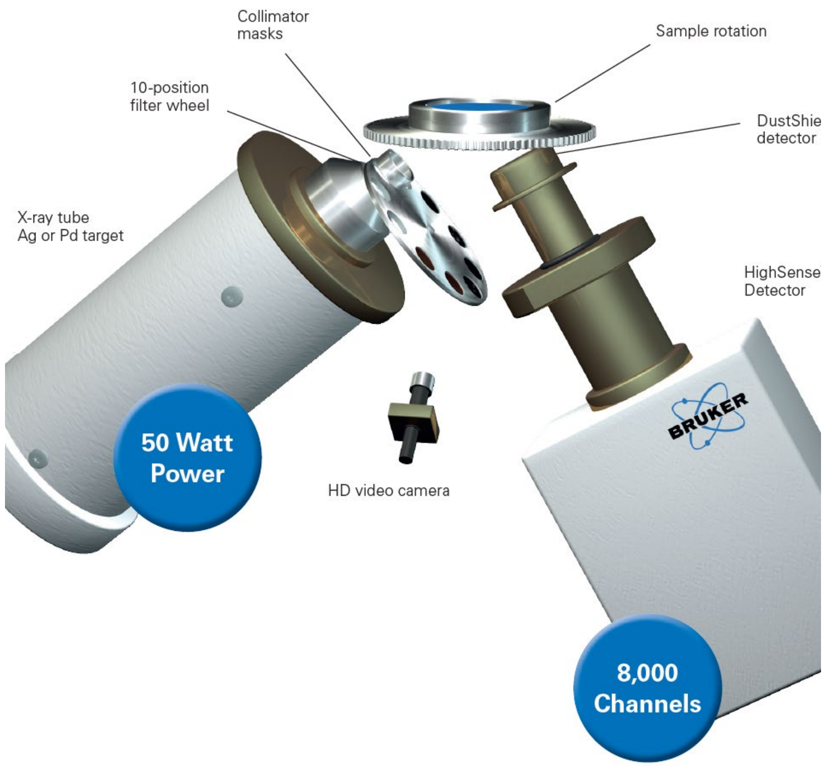
UV/VIS Spectroscopy (UV)

- Requires reagents for UV reaction

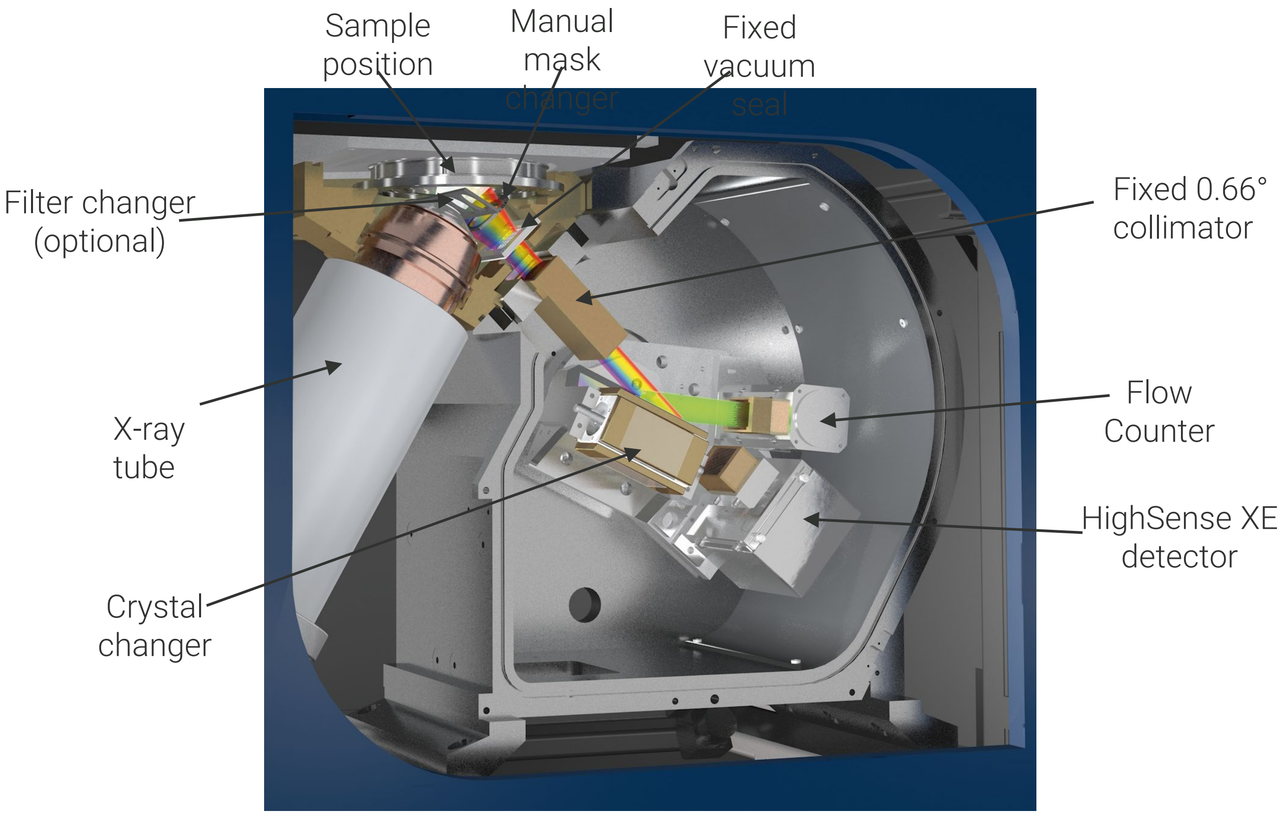



Energy-Dispersive XRF (EDXRF) vs. Wavelength-Dispersive XRF (WDXRF)

EDXRF



WDXRF



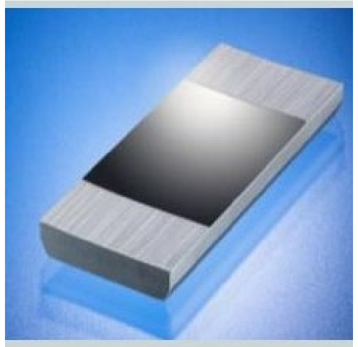
X-ray Fluorescence Analysis (XRF)
The Comparison of Energy and Wavelength Dispersive Spectrometers

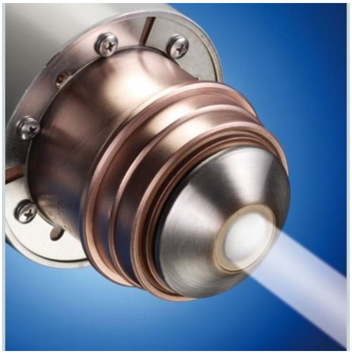
EDXRF

- Mechanical simplicity
- Cheaper
- Sensitivities: down to the ppm level
- Easy operation
- Smaller, “can be brought to the sample”

WDXRF

- High precision mechanics
- Higher capital
- Precision: <0.05%
- Higher resolution
- Sensitivities: down to the ppm level, but roughly one to two orders more sensitive
- Very fast analysis
- Highest sample throughput





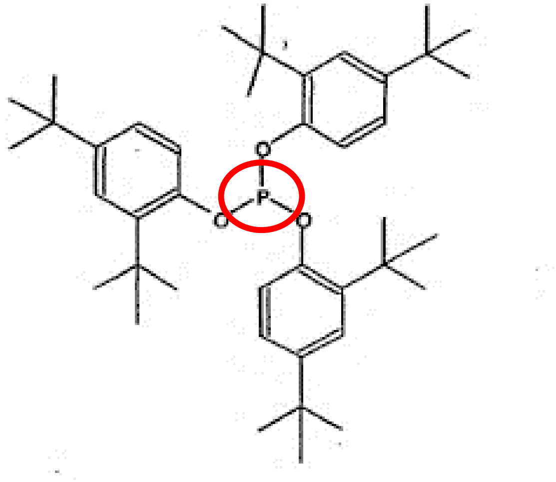
Polypropylene (PP) Application

- Polypropylene (PP) is a thermoplastic polymer
- Used in wide variety of applications as plastic and fiber in:
  - Industrial applications
  - Consumer goods
  - Packaging industry
  - Automotive industry

- Direct analysis of granules, prepared as solid specimen (PUK) after hot pressing
- Analysis of granules in liquid cups
- Additives in polymer processing
  - Talc (Si)
  - IRGAFOS 168 (P)
- Calibration for Si and P, or directly by additive concentration

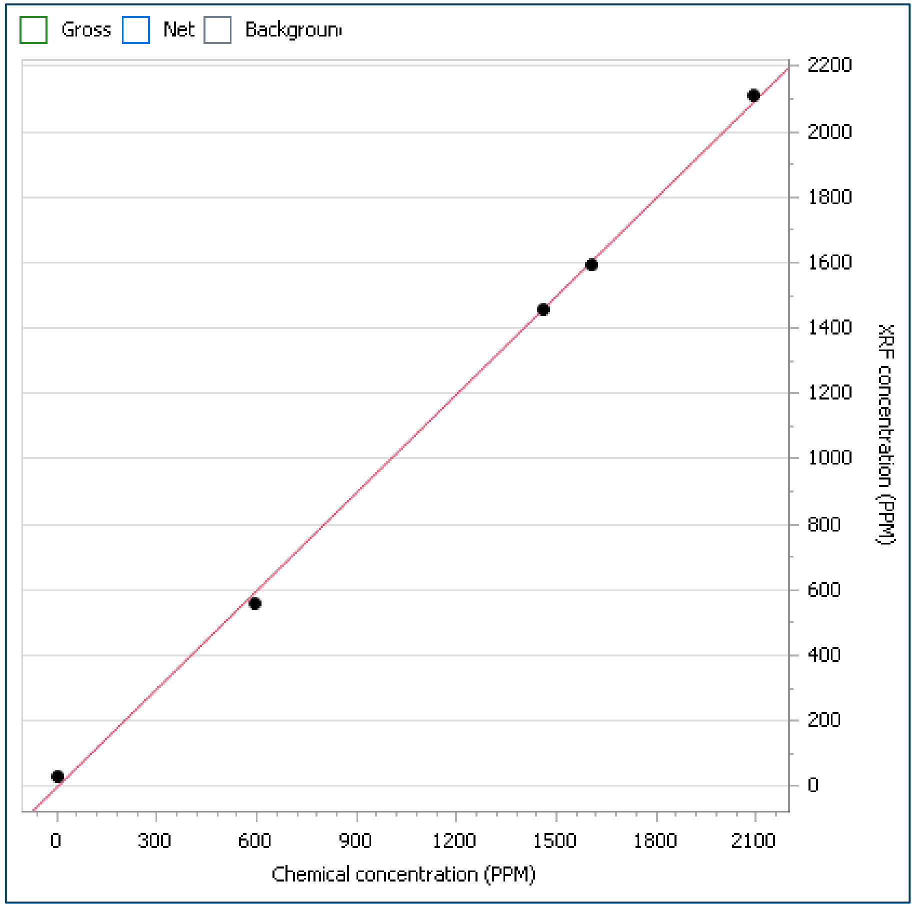
Polymer Analysis with XRF
How does it work?

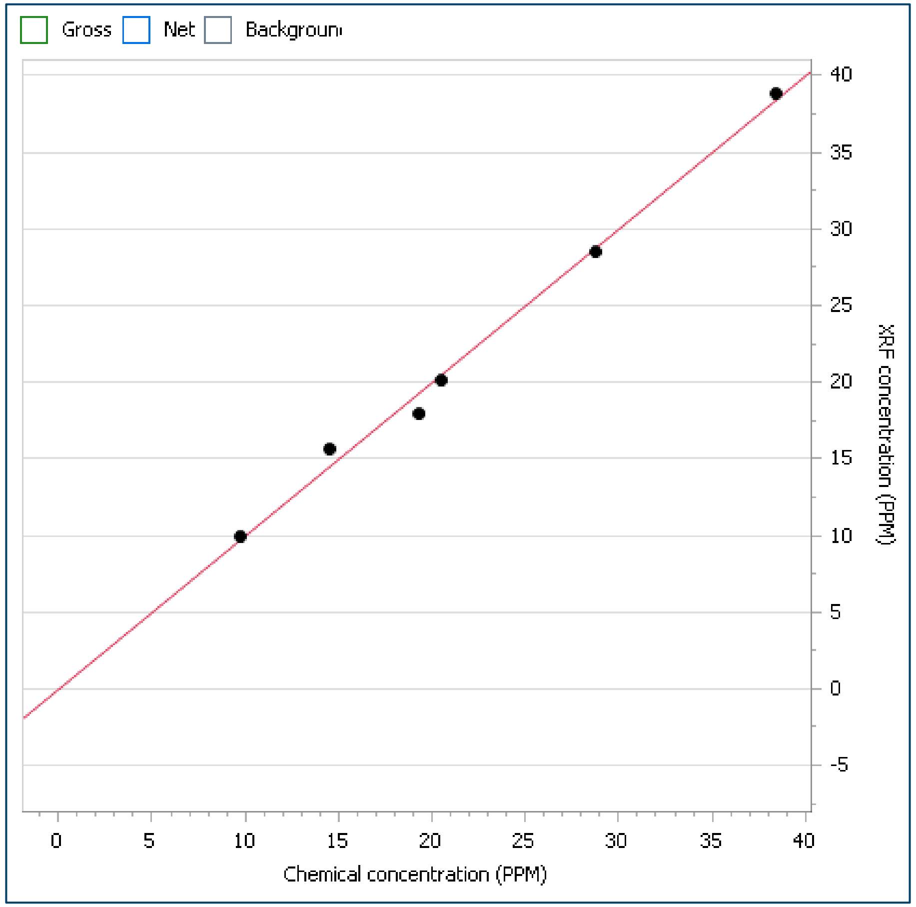
- Additive compound IRGAFOS 168



- XRF provide elemental information
- Stoichiometry by calculation or user input
- Evaluation based on 100% known matrix, i.e. everything is measured
- Polymer: matrix is balance (100-X) as $\{C_xH_yO_z\}$

Si and P in Polypropylene (PP) S2 POLAR





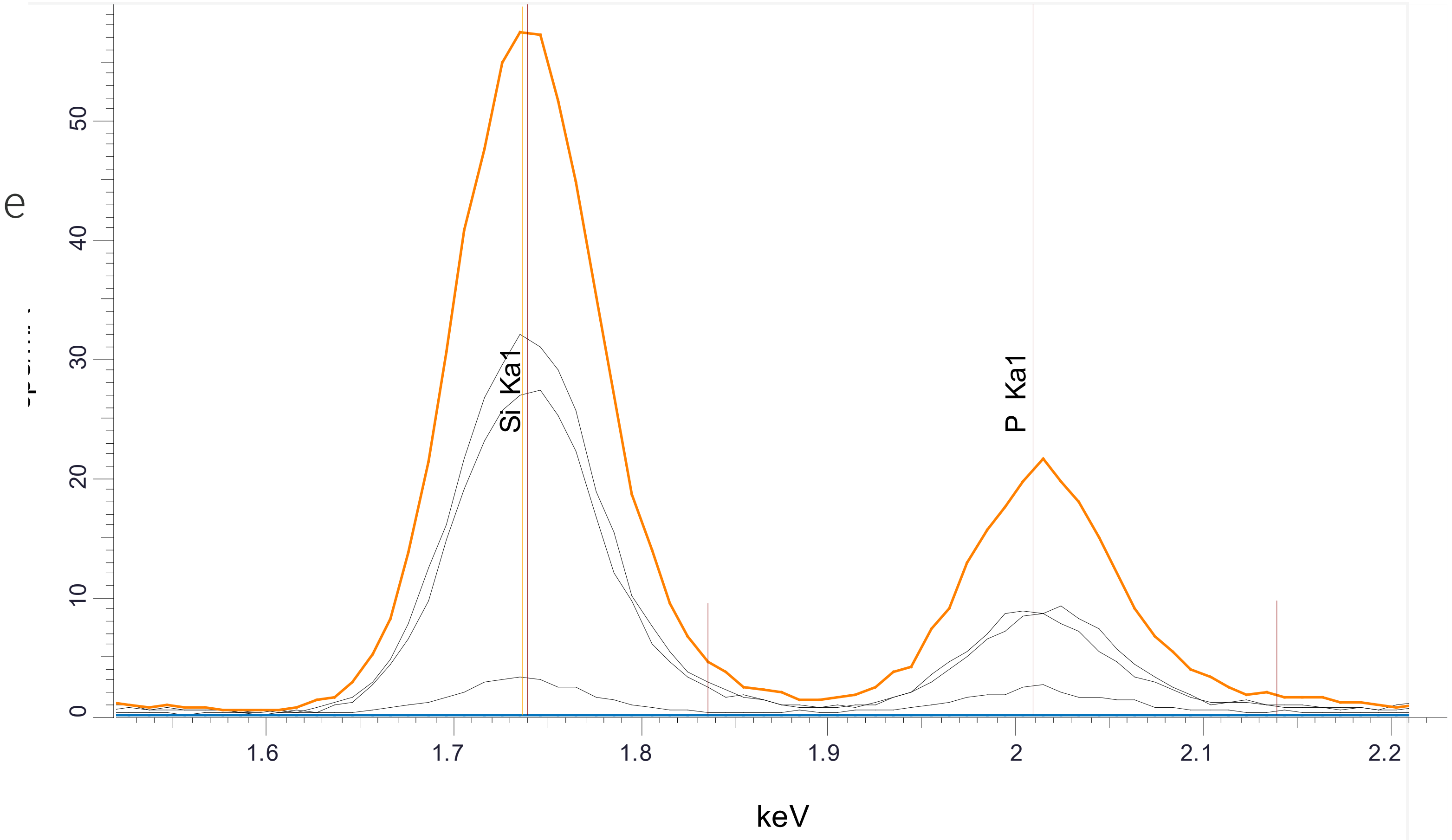
- Si in PP – up to 2100 ppm (LLD: 0.7 ppm)
- P in PP – up to 40 ppm (LLD: 0.3 ppm)

Si and P in Polypropylene (PP) S2 POLAR

Advantages of XRF

- Simple sample preparation
- Quantitative and qualitative possible
- Fast screening
- Fingerprint material identification
- Linearity from ppm to 100%
- Long term stability
- No daily recalibration

- Process monitoring
- Quality control



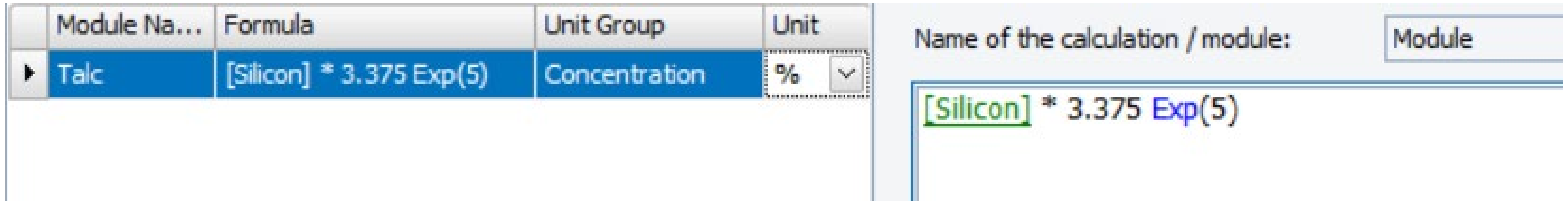
- Excellent separation of Si and P element lines

Polypropylene (PP) Application SPECTRA.ELEMENTS Feature

- Many users in polymer industry, do not directly report measured concentration for process control

- Bruker's software feature allow customized module for data reporting

- E.g. Si concentration is reported as "Talc" by a conversion formula: Si (%) x 3.375 x 10^5



- It is also possible to setup in house calibration directly with the compounds "Talc"

Benchtop EDXRF for Petrochemical Applications S2 POLAR

- Elemental analysis of key additives in polymers
- Very small, compact footprint
- For space-saving analysis in labs
- Also important for on-site process control with limited space in refineries, tank terminals, depots
- Ready-to-analyze ‘One Button’ solutions, e.g.
- Norm-compliant to ASTM D7220, D4294, ISO 13032

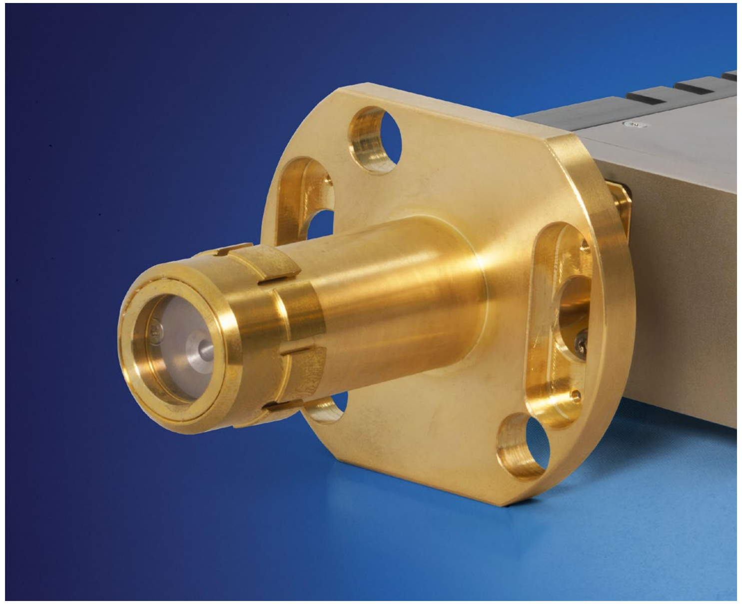
One instrument does it all for refineries:

From Ultra-Low Sulfur (ULS) in fuels to % in crudes

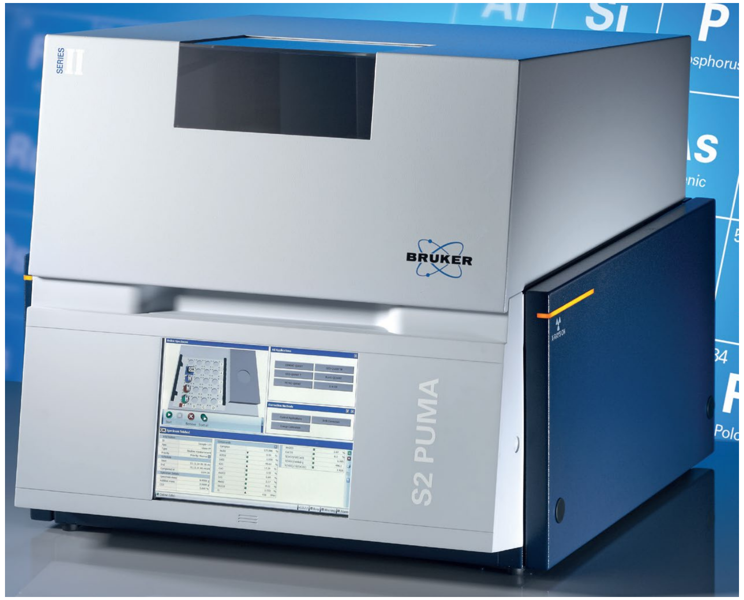
HighSense^{TM} XP Detector
Now available for the S2 PUMA Series 2

State-of-the-Art Hardware & Next Generation Software

- New premium detector for all elements (C to Am)
- Robust, high transmission Graphene window (non-toxic)
- Bruker's detector chip technology
- Further enhanced cooling (Peltier) performance



New HighSense XP Detector

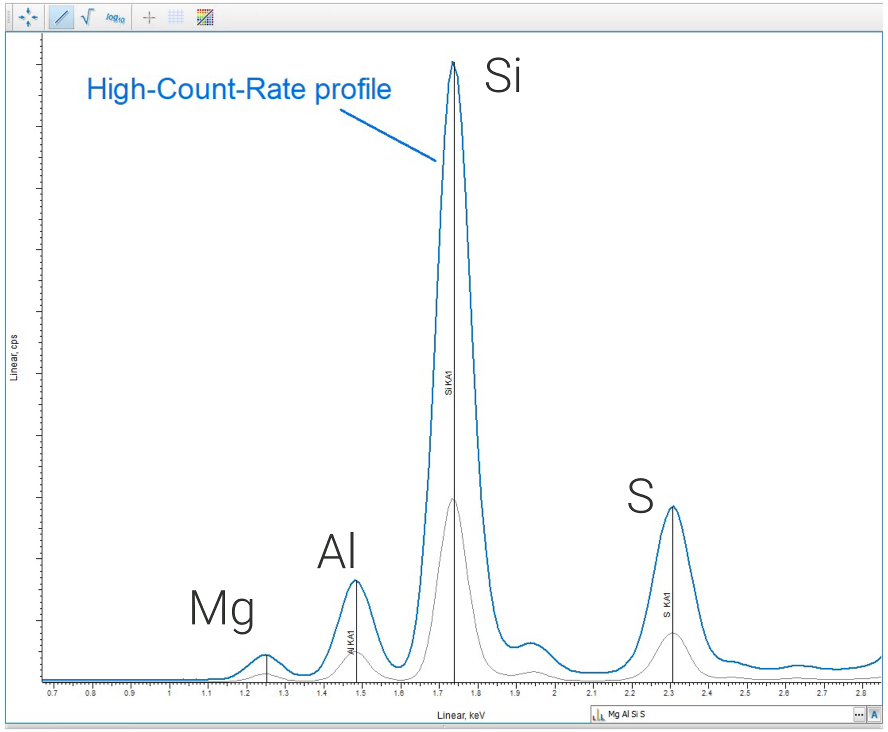


S2 PUMA Series 2 with XY Autochanger

- New SPECTRA.ELEMENTS with Dynamic Detector Profiling

The Benefits of Detector Profiling

- New, fully integrated feature in SPECTRA.ELEMENTS
- Flexible: Make your selection each analytical range
  - **High Resolution** for optimal peak separation of neighboring elements
  - **High-Count-Rate** to boost the throughout or decrease LLD



SPECTRA.ELEMENTS

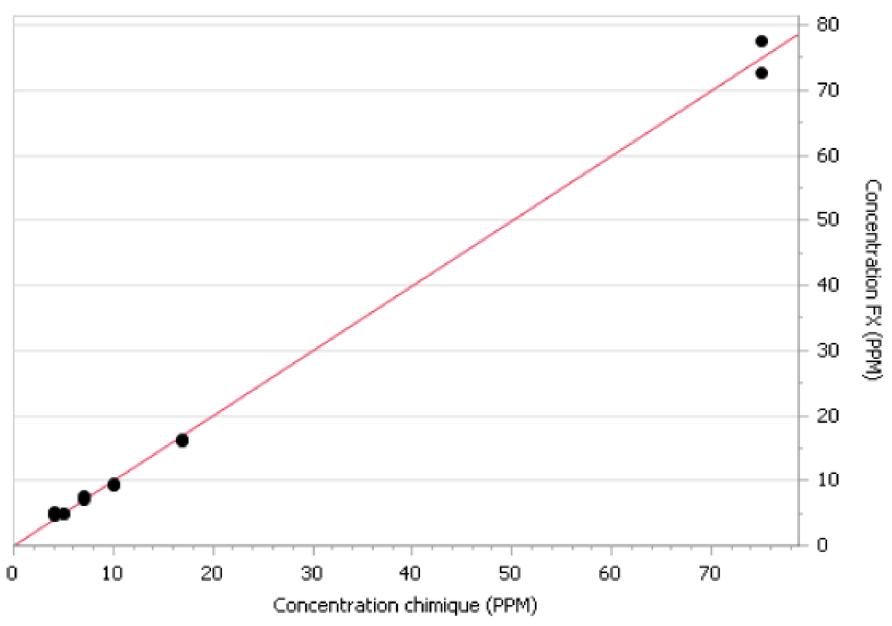
Easy. Fast. Smart. Powerful.

Achieve up to 4 x higher net intensity with the High-Count-Rate profile

→ Enhance the performance for heavy trace elements in polymers

Ni in Polymer Powder S2 PUMA

- The direct excitation of the S2 PUMA results in better performance for heavier elements when compared to the S2 POLAR
- Example Ni measured in polymer powder samples w/o any sample preparation in liquid cup under air
- Excellent repeatability at such low concentration levels



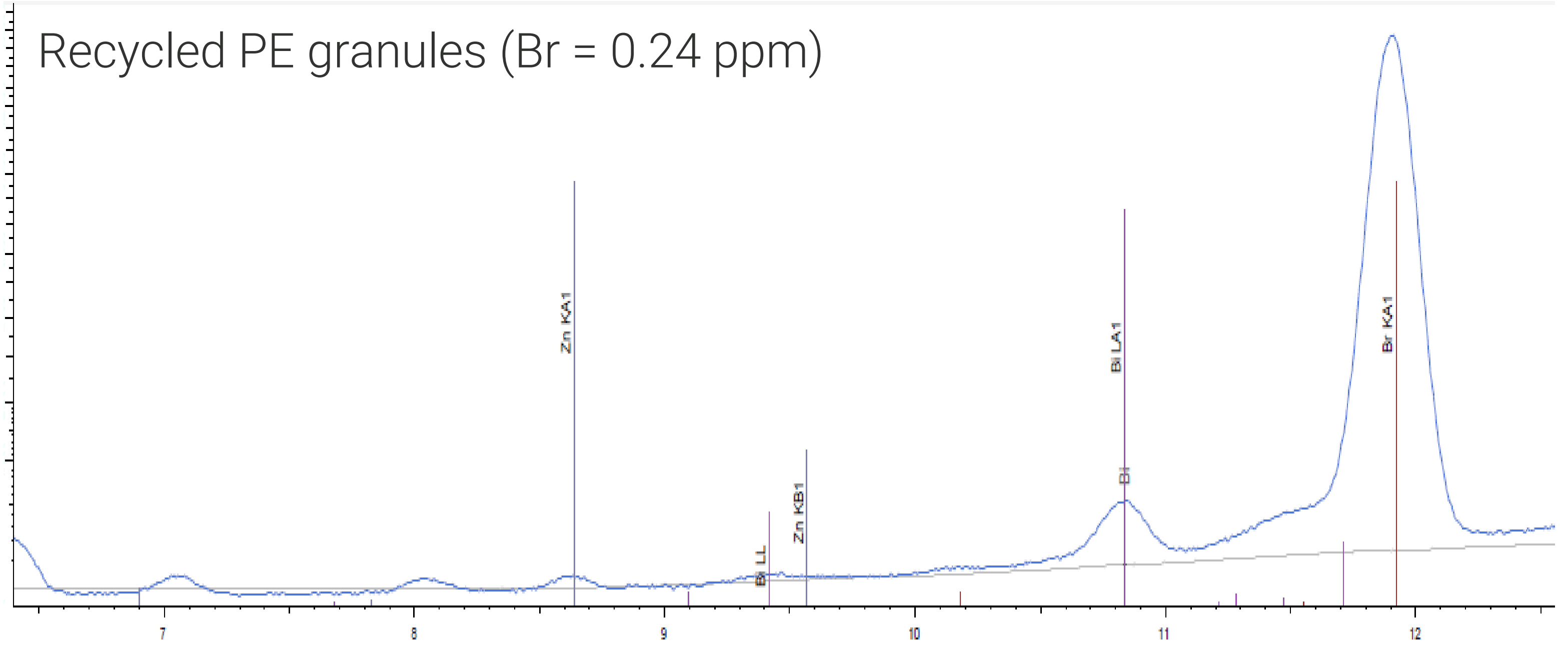
# Measurement	Ni [ppm]
1	4.9
2	5.0
3	5.0
4	4.9
5	5.0
6	4.9
7	4.9
8	4.9
9	4.8
10	5.0
Average	4.9
Std. Dev.	0.1
Rel. Std. Dev.	1.29 %

SMART-QUANT FP
Best Standardless Analysis with EDXRF

SMART-QUANT FP is set up to work in full Fundamental Parameter (FP) mode – this means no calibrations necessary!

Excellent for raw material testing and whenever special samples outside the analytical routing need to be measured.

- Fluorine to Americium
- ppm to 100%
- Air, Helium, Vacuum
- 30 and 50 kV



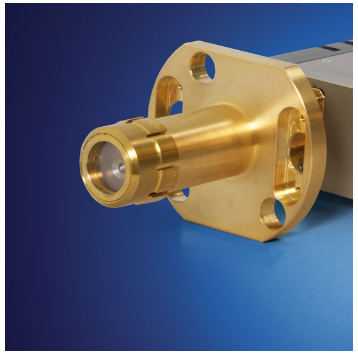
SMART-QUANT: Push-button solution for quick and reliable analysis of unknown samples

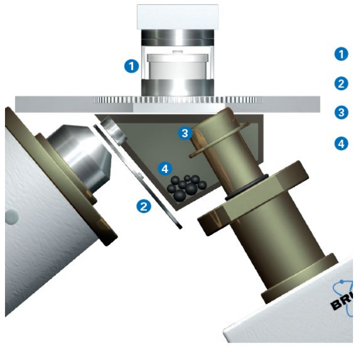
S2 PUMA Series 2
A versatile Benchtop EDXRF

- 50 W X-ray tube
- Direct excitation
- HighSense detector technology
- SampleCare™
- SMART-QUANT FP

- Elemental analysis of all kinds of additives, such as stabilizers, fillers, processing aids, pigments, anti-block/static agents, flame retardants, …

- Sample Handling for all needs:
  - Single (for manual loading, few samples/day)
  - XY-Autochanger (for high throughput)
  - Carousel (for large polymer samples, various sizes)
  - Mapping-Stage (multi-spot analysis on polymer discs, up to 6 inch)



S6 JAGUAR - Benchtop WDXRF
High Performance Benchtop WDXRF

Configurable from single element analyzer for S to multi-purpose unit for the periodic table

All-new technology and software:

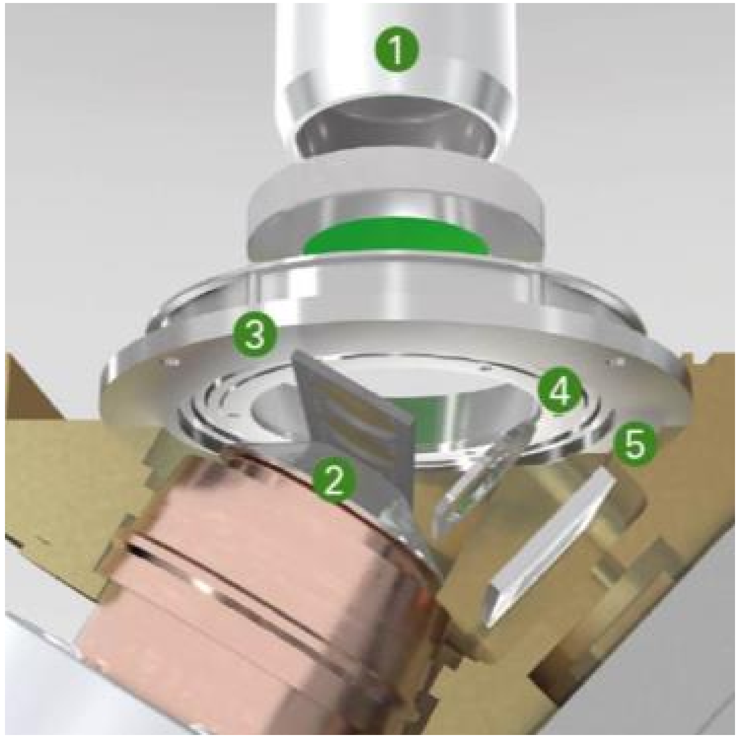
- Long lifetime X-ray tube
- Compact goniometer with high precision gears and closely coupled X-ray beam path
- Optimized analyzer crystals for the entire element range and special applications
- HighSense detection with 2 Mcps countrate
- HighSense XE detector for medium and heavy elements
- SPECTRA.ELEMENTS analytical SW
- SMART-QUANT WD with new FP algorithms

S6 JAGUAR Benchtop WDXRF

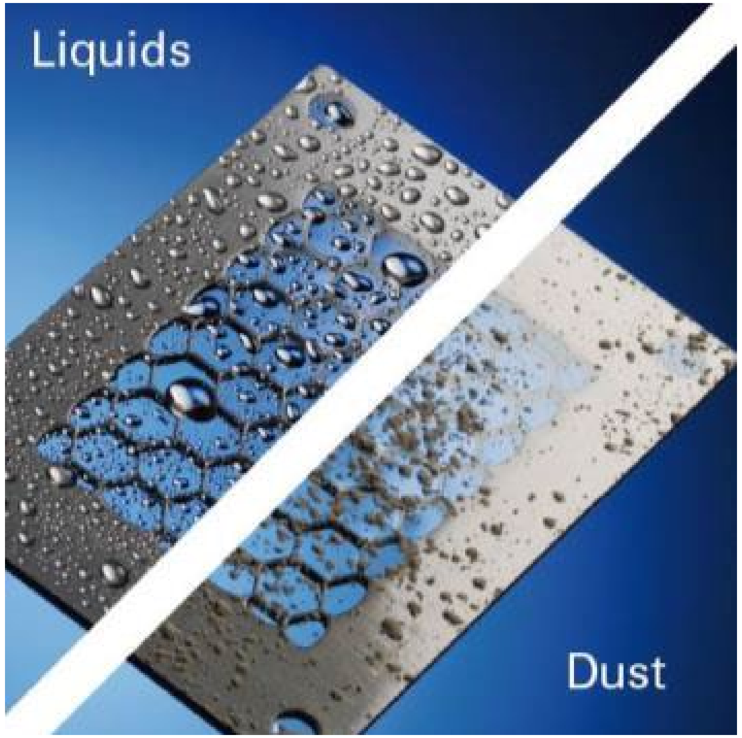
400 W excitation

S6 JAGUAR
SampleCare™: High Instrument Uptime & Low cost of operation

- High instrument uptime due to unique protection during loading and unloading
- Two contamination shields to protect tube window and goniometer
- Unique Vacuum Seal with high transmission window for goniometer protection
- Low helium consumption
  - Flushing of sample chamber only
  - Goniometer chamber remains in vacuum all the time



1 Grabber with automatic sample detection
2 Tube shield
3 Filter changer
4 Mask holder
5 Vacuum seal



Unique High Transmission Vacuum Seal

Additives in Polymer S6 JAGUAR

Analysis of additives and impurities in virgin polymers:

- Mg, Al, Si, P, Cl, Ca, Ti, Zn Zr in the lower ppm range
- Aim: High accuracy in the trace element region

- Direct analysis of solid specimen (PUK), after hot pressing
- Analysis of granules in liquid cups

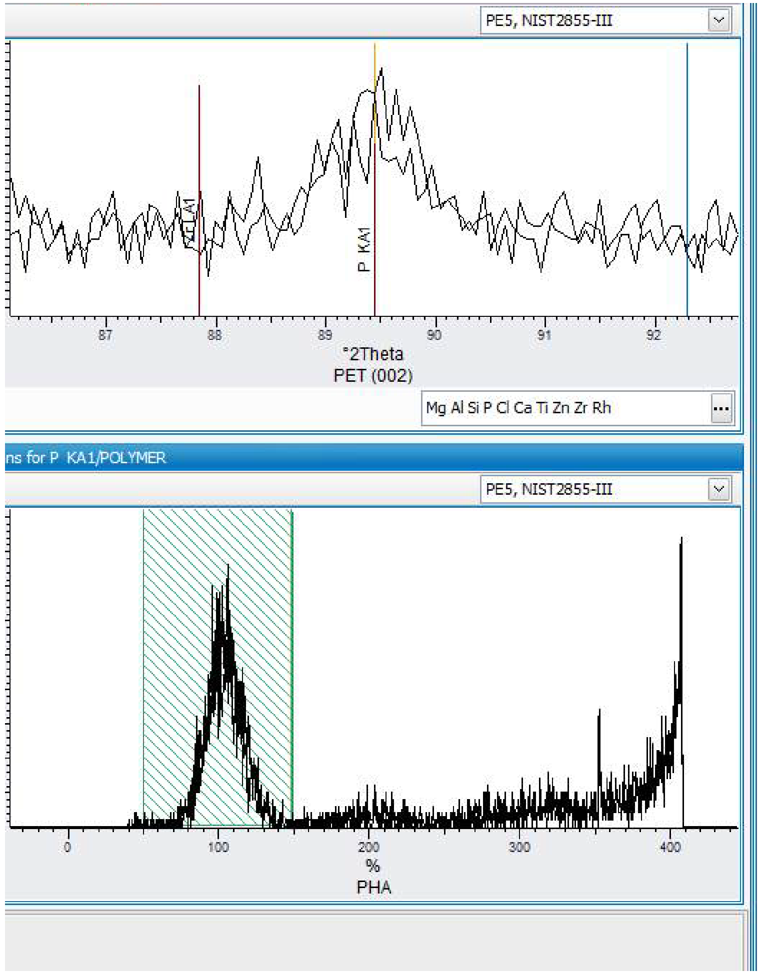
Polymer prepared as PUK (Hot press) or mold

Granulate directly analyzed in a liquid cup with thin film bottom

Additives in Polymer
S6 JAGUAR

Setup scans for P Ka in Polymers

- High resolving WDXRF separates Zr La from P Ka
- High power setup with closely coupled beam path leads to optimal detection limits
- Low temperature tube head maintains samples (no decomposition)

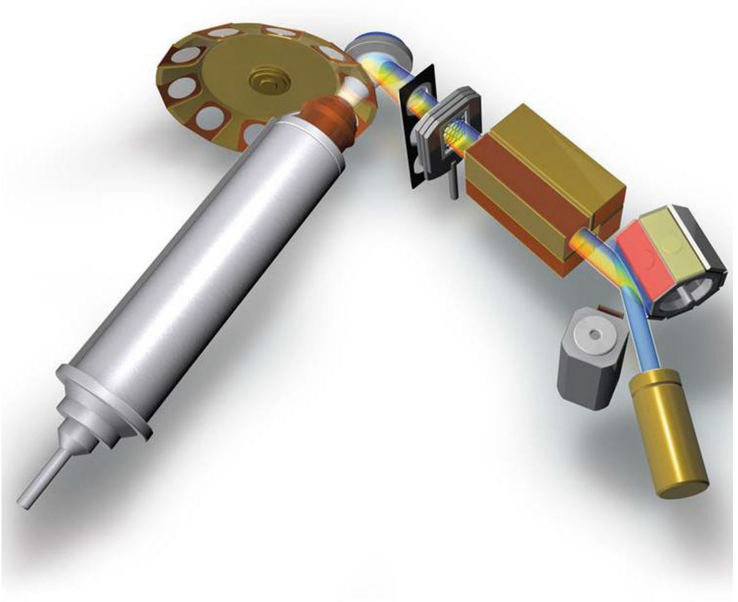


Multi Purpose Sequential WDXRF Spectrometer S8 TIGER for the Central Lab

Analytical flexibility and high performance for sub-ppm traces

- 4 kW excitation
  20 – 60 kV
- 5 – 170 mA
- 10 beam filters
- 4 collimators
- 8 crystals
- 2 detectors

Efficient tube head cooling prevents samples from decomposition



S8 TIGER WDXRF Beam path

Floor standing WDXRF S8 TIGER

with 1, 3 or 4 kW

XRF - Solutions for Industry and Research
S8 TIGER

Ready-To-Analyze Solutions for optimal Performance

- Factory setup
- Quick start into routine
- Ease-of-Use
- Best results
- Bruker expertise built in

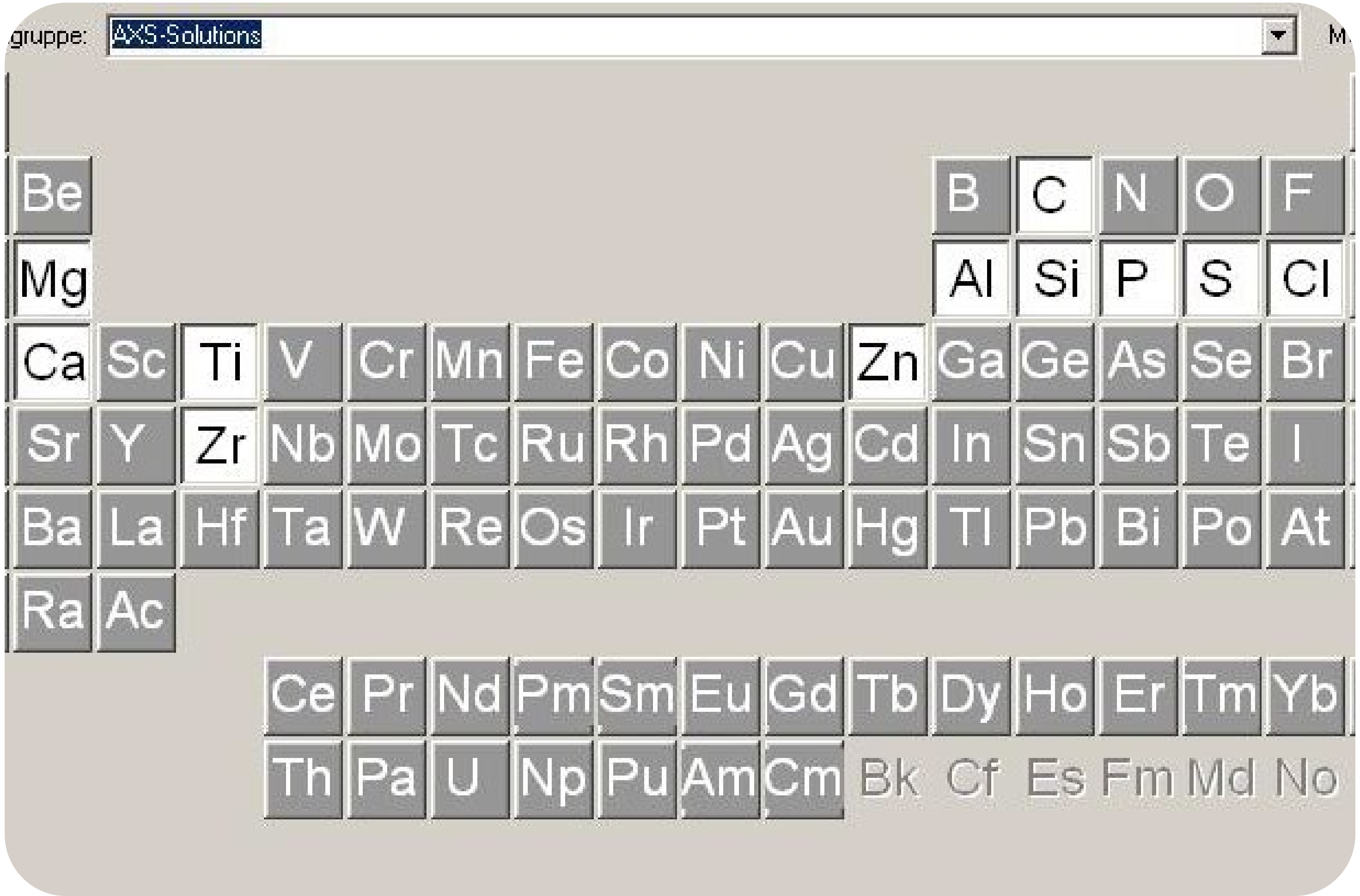
POLYMER-QUANT A S8 TIGER

POLYMER-QUANT is the ready-to-analyze solution for additives in polymers:

- covering more than 10 elements
- in polymer disks and granules
- contains certified standard materials from NIST as acceptance test sample

POLYMER-QUANT A
Applications

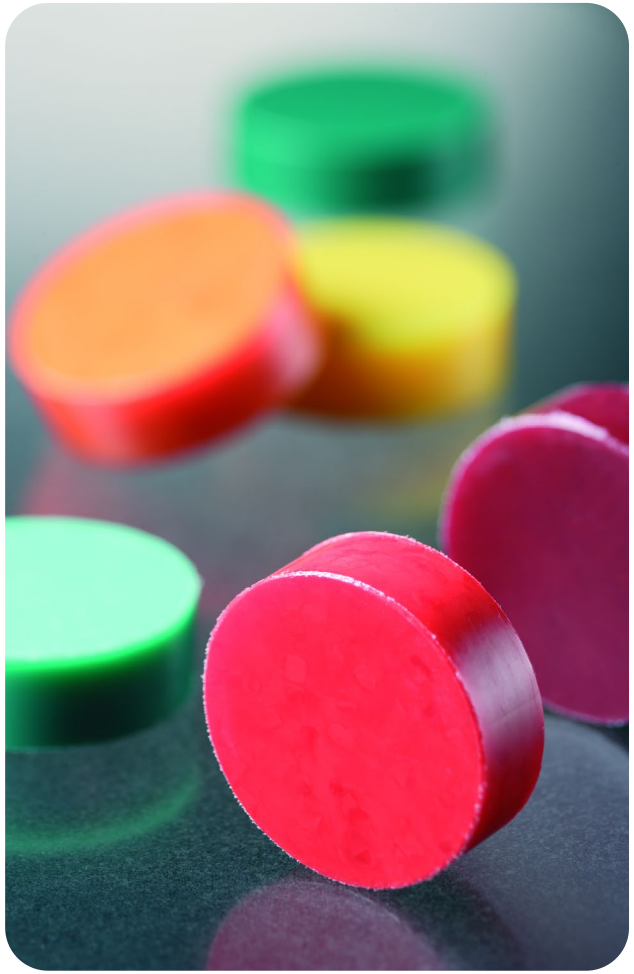
- Contains all relevant additive elements and catalyst residues in polymers
- Covers the analysis of virgin polymers with typical concentration ranges
- In all CH based polymer types with the variable alpha model (PE, PP, PET, ABS,…)



POLYMER-QUANT A
Covered Concentration Range

- Concentration ranges are covering the typical range (Remember, an additive just contains partially Ca, Mg,.. remaining rest of the weight is the “soap, additive,…”

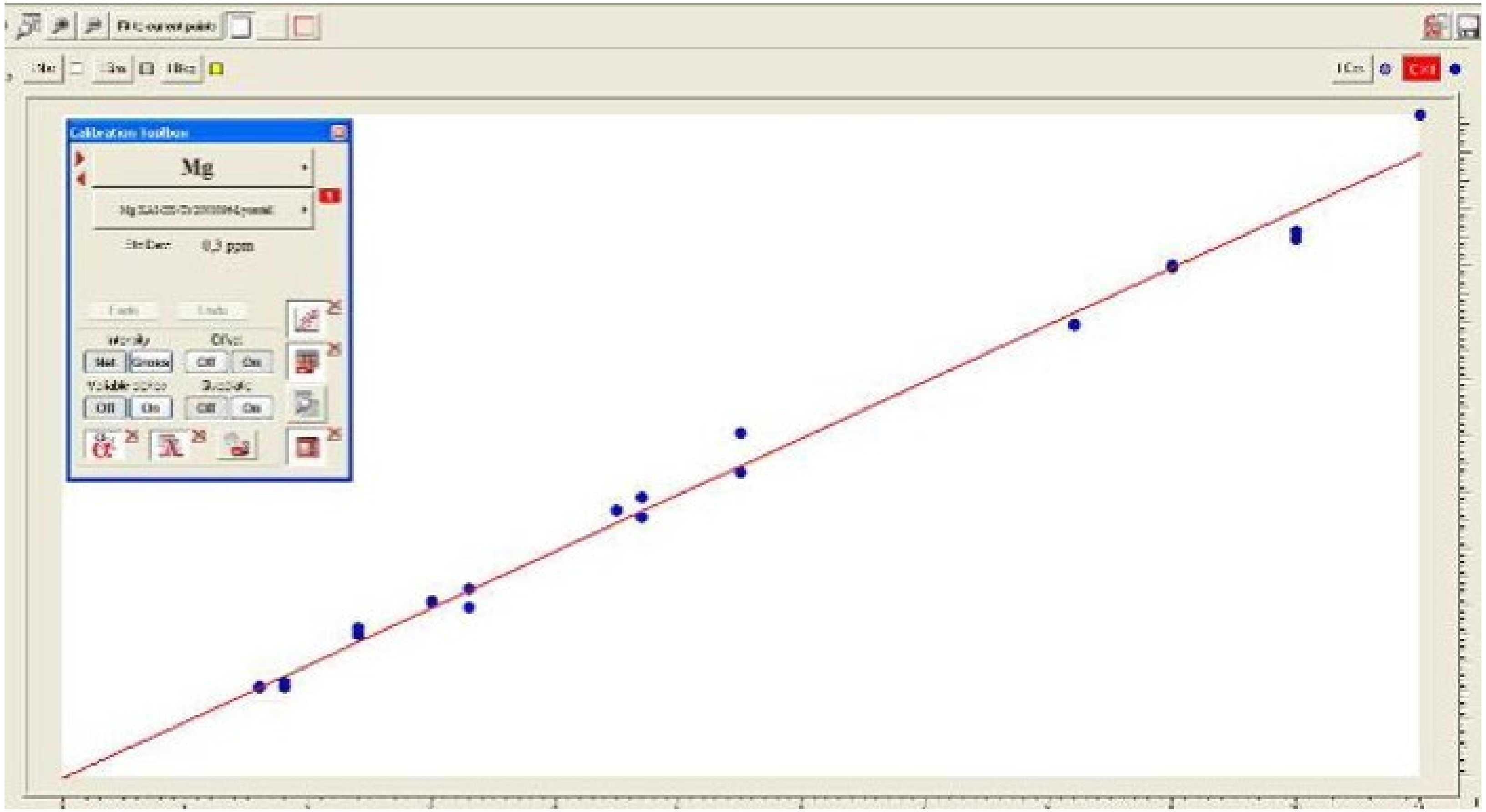
	Mg [ppm]	Al [ppm]	Si [ppm]	P [ppm]	S [ppm]	Cl [ppm]	Ca [ppm]	Ti [ppm]	Zn [ppm]	Zr [ppm]
Min.	2	26	5	1	1	10	0	0	0	3.5
Max.	495	260	1198	210	41	1250	125	99	807	76



Traces of Mg in Polymers
S8 TIGER

Mg in Polyethylene:

- Impurity from production
- Efficiency improved due to reduced loss of catalyst
- LLD: 0.2 ppm



Traces of Mg in Polymers
S8 TIGER

- Excellent analytical precision of less than 0.1 ppm @ 5 ppm enables accurate determination and control of the additive

# Measurement	Sample 1 Mg [ppm]	Sample 2 Mg [ppm]
1	5.5	1.8
2	5.7	1.6
3	5.6	1.7
4	5.4	1.5
5	5.6	1.8
6	5.7	1.7
7	5.8	1.6
8	5.7	1.5
9	5.7	1.6
10	5.4	1.6
Average	5.6	1.6
Std. Dev.	0.1	0.1

POLYMER-QUANT A – Set of Standards S8 TIGER

POLYMER-QUANT A

- Contains calibration standards (Polyethylene and Polypropylene) as granules
- NIST certified reference material as acceptance test samples
- Drift correction samples
- Operators Manual
- Installation CD

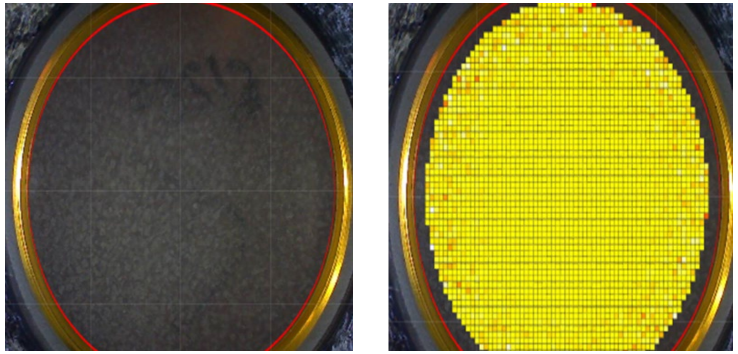
Analyzing just the Element Concentration? Get the Distribution!

Analyzing the distribution of an element inside the sample

- The all-new S8 TIGER Series 2 XRF[2] : TiO_2 in polymers
- Mapping
- 300 µm spot size
- Ti Ka1; 4 s

Homogenous distribution, no hot spot

- TiO2 as additive in virgin polymer (PE)
- Question solved: Homogenous Distribution of the TiO2 in the polymer

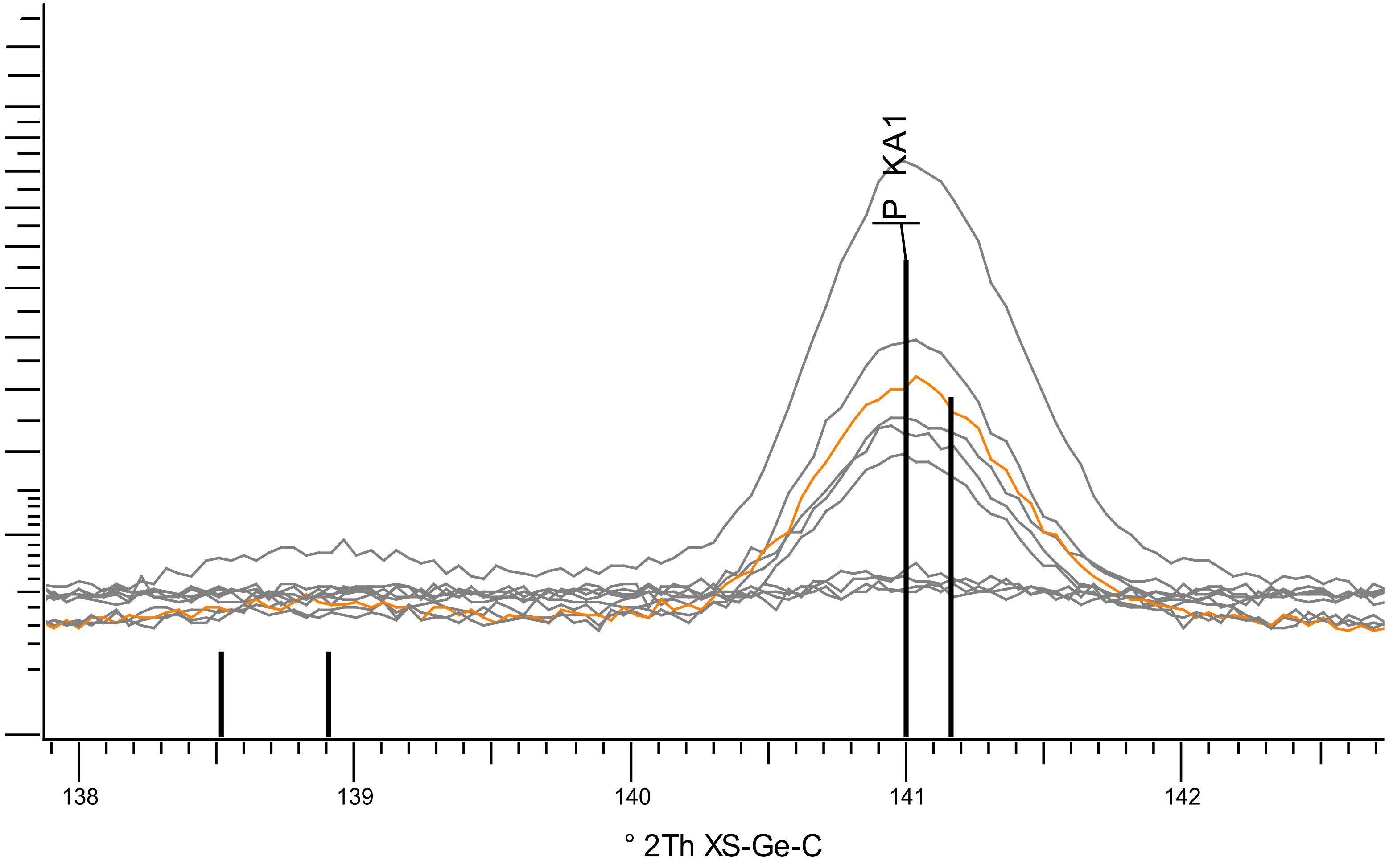


Analysis of Additives
S8 TIGER

- Determination of additives
  - Precise evaluation of the concentration level for the optimal dosing of valuable substances
  - Selection of tracer element for organic additives, which cannot be determined directly
    - e.g. P as marker for PS 38 or PS P-EPQ

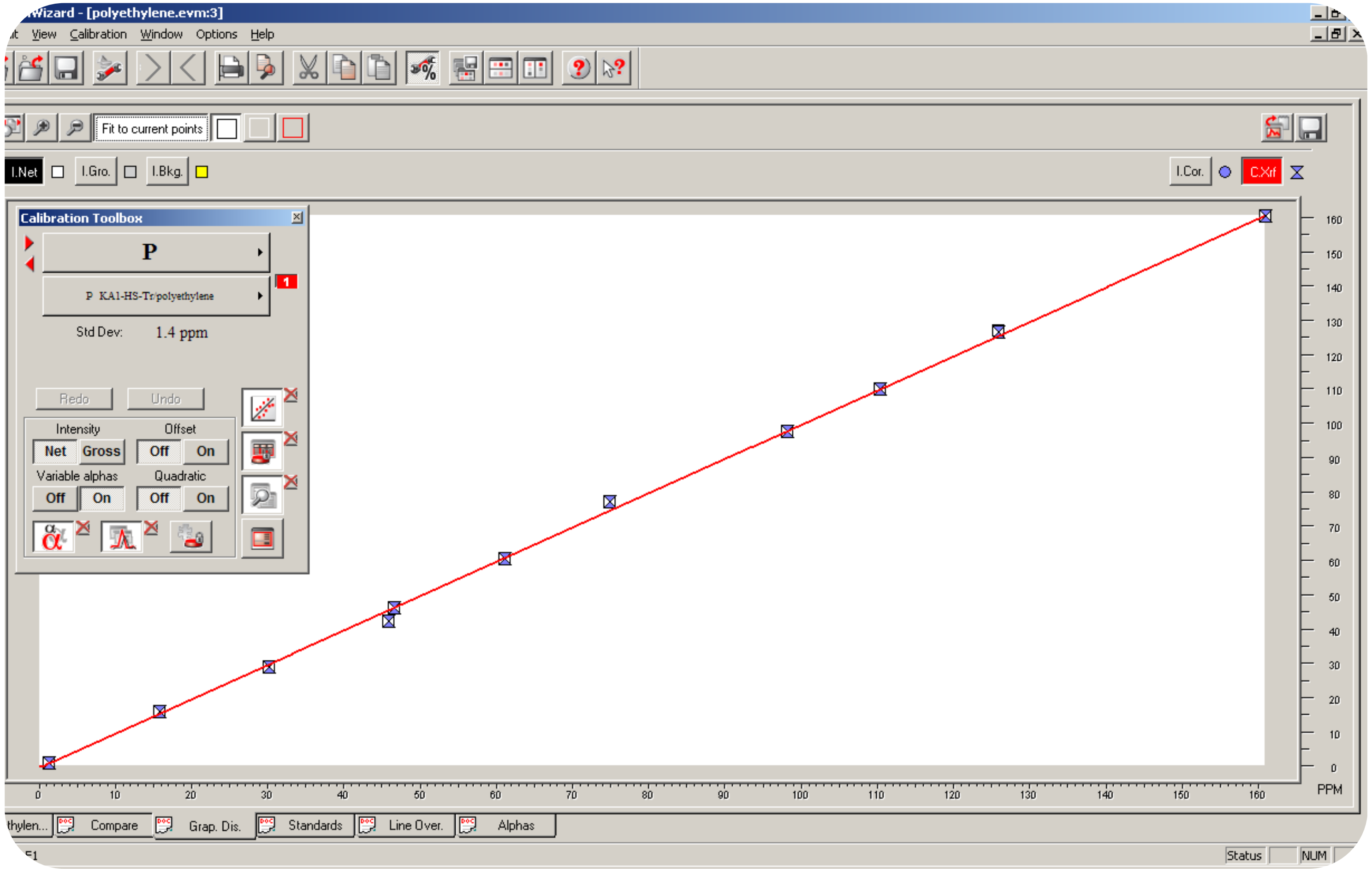
- Analysis of solids as hot pressed PUK under vacuum
- Analysis of granules in sample cups under helium
- Selection of soft excitation condition to reduce the heat dissipation from tube to sample

Additives in PE
Analysis of Phosphorus with the S8 TIGER



- Separation of P Ka from neighboring peaks
- Use of high intensity and best resolution crystal XS-Ge-C

Additives in PE
Analysis of Phosphorus with the S8 TIGER



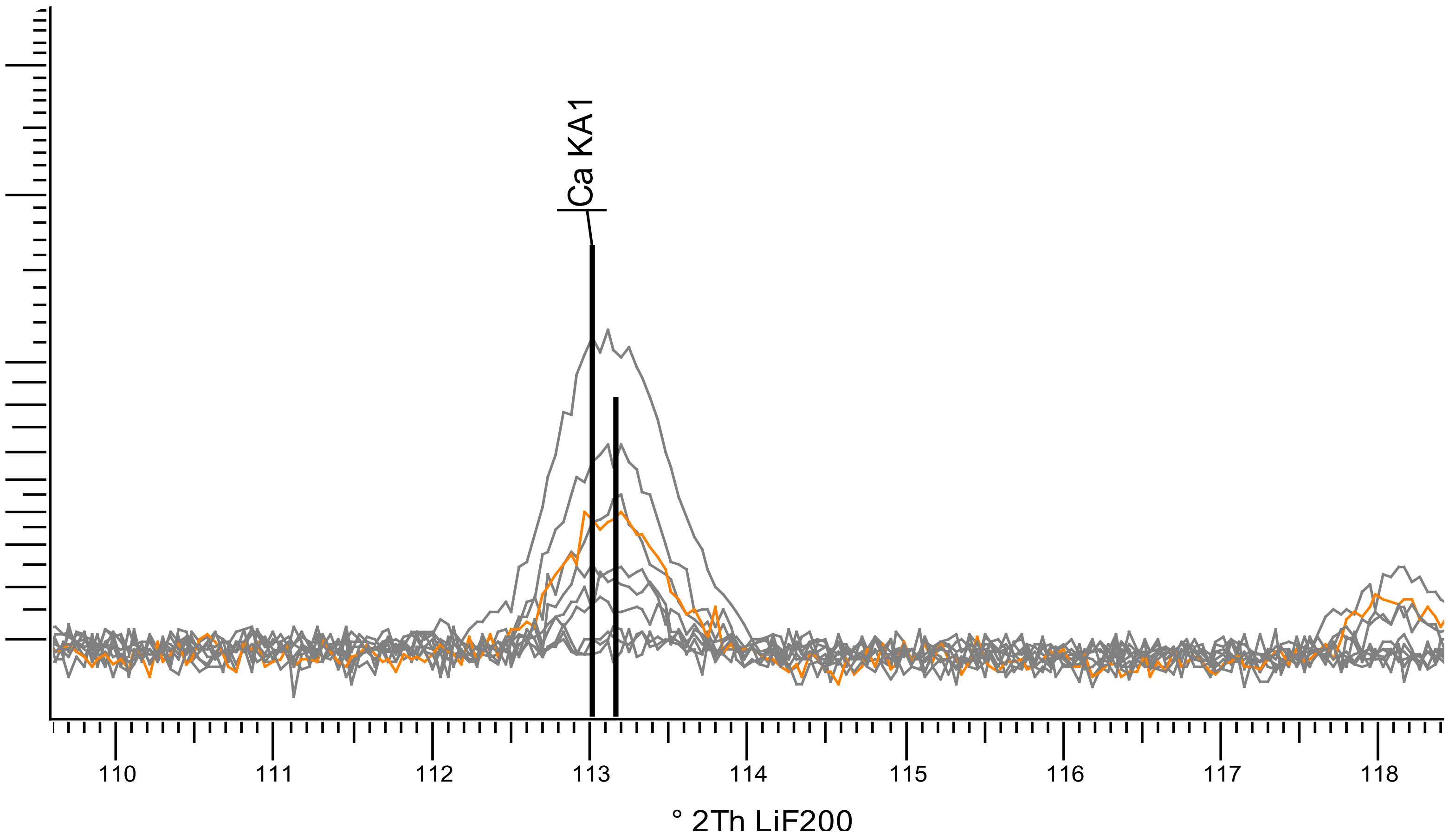
- Linear range of up to 160 ppm P
- Calibration Std. Dev. max 1.4 ppm
- Zero ppm offset

Additives in PE
Analysis of Phosphorus with the S8 TIGER

- Direct analysis of solid samples (disks - PUK) from a hot press or as granules
- Detection limit of 0.3 ppm (3 σ, 60 s)
- Optimal detection with clear separation from other elements

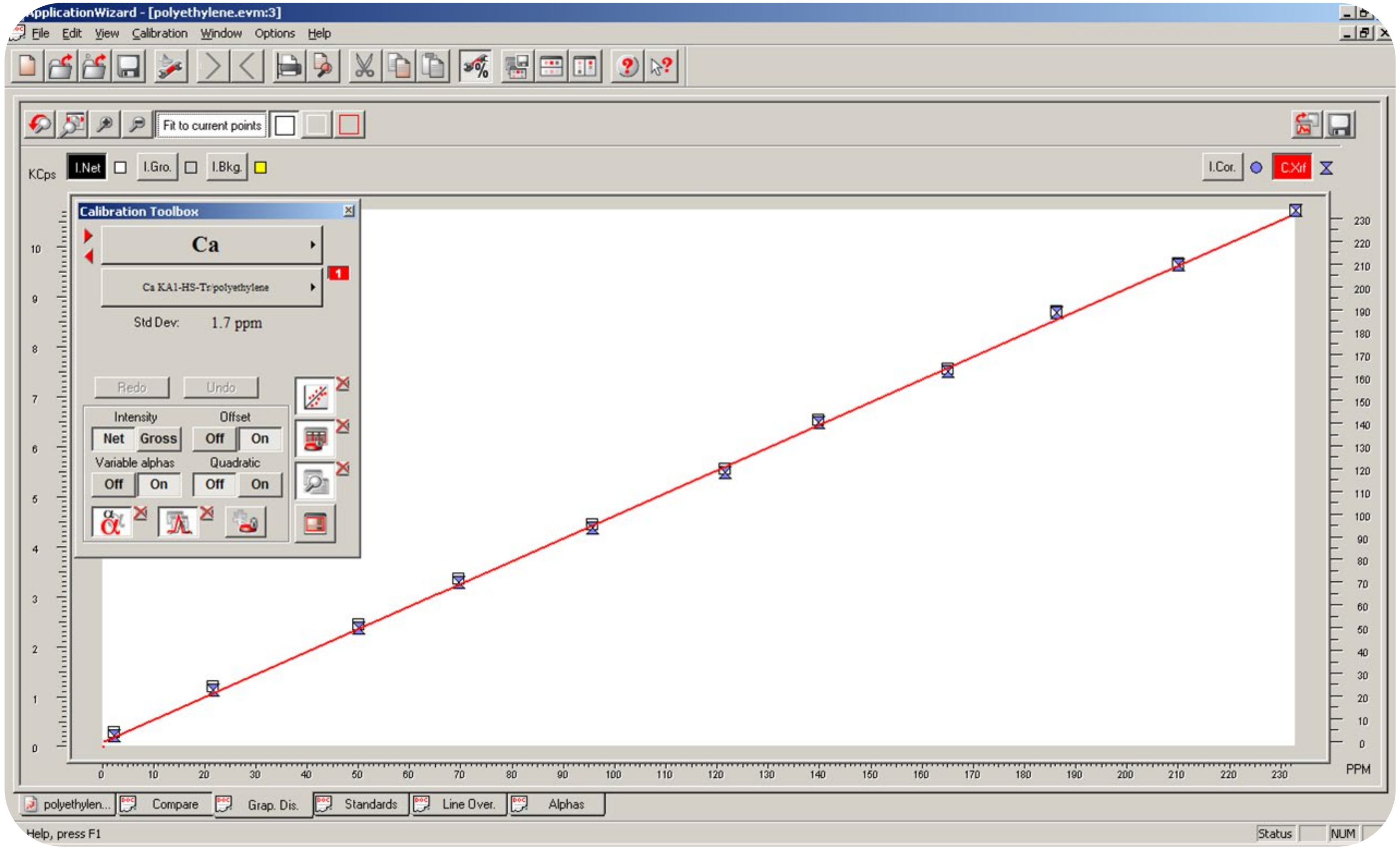
Number	Standard Name	Chemical Concentration	XRF Concentration	Absolute Deviation	Relative Deviation	LLD (PPM)
14	AB-1	1.3	1.2	-0.1		0.3
10	AB-2	15.7	16	0.3	1.7	0.3
20	AB-3	30.1	29	-1.1	-3.5	0.3
17	AB-4	45.8	42.6	-3.2	-7.1	0.3
15	AB-5	46.6	46.4	-0.2	-0.36	0.3
13	AB-6	61	60.5	-0.5	-0.75	0.3
11	AB-7	74.8	77.4	2.6	3.4	0.4
16	AB-8	98.2	97.7	-0.5	-0.48	0.5
12	AB-9	110.3	110.1	-0.2	-0.16	0.5
18	AB-10	125.8	126.9	1.1	0.87	0.5
19	AB-11	160.8	160.4	-0.4	-0.23	0.6

Additives in PE
Analysis of Calcium with the S8 TIGER



- Separation of Ca Kα from neighboring peaks
- Flat background, no background determination required

Additives in PE
Analysis of Calcium with the S8 TIGER



- Optimal linear range of up to 300 ppm Ca
- Calibration Std. Dev. of less than 2 ppm
- Extended range to % level possible

Additives in PE
Analysis of Calcium with the S8 TIGER

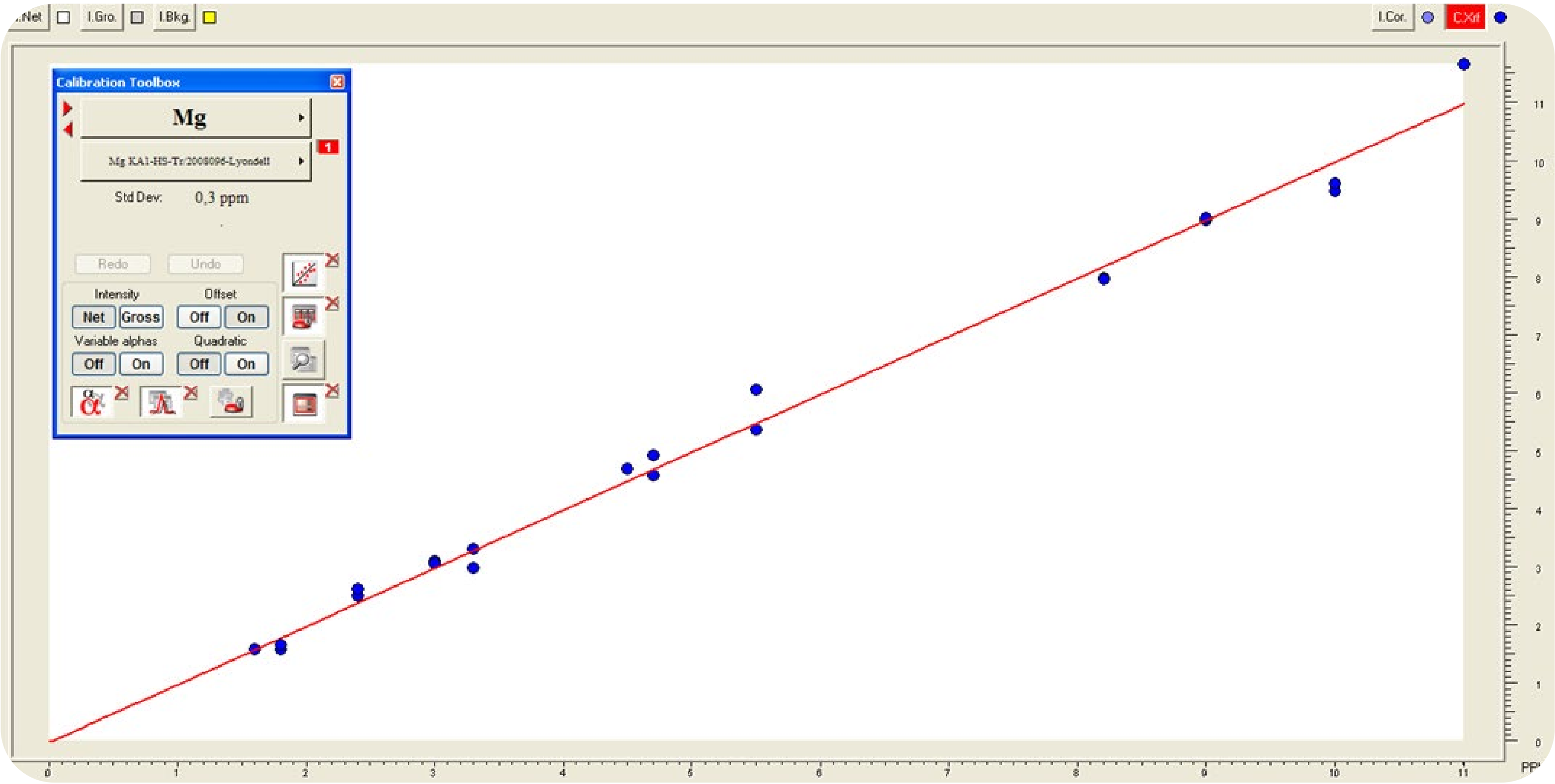
- High accuracy allows exact determination of the mixture of polymer with the additive
- Maximum deviation 2 ppm (1% relative)
- Detection limit of 1 ppm (3 σ, 60 s)
- Less thermal stress on samples reducing the measurement time
- No background measurements required

Number	Standard Name	Chemical Concentration	XRF Concentration	Absolute Deviation	Relative Deviation	LLD (PPM)
1	P1	2.3	2.5	0.2		0.5
2	p2	21.6	22.8	1.2	5.4	0.5
3	p3	50	50.1	0.1	0.24	0.6
4	p4	69.4	70.2	0.8	1.2	0.7
5	p5	95.6	94	-1.6	-1.7	0.9
6	p6	121.5	118.5	-3	-2.5	1
7	p7	139.6	140.4	0.8	0.6	1.1
8	p8	165	162.9	-2.1	-1.2	1.1
9	p9	186.2	189	2.8	1.5	1.1
10	p10	210	209.8	-0.2	-0.073	1.4
11	p11	232.7	233.6	0.9	0.37	1.4

Analysis of Initiator Residues
S8 TIGER

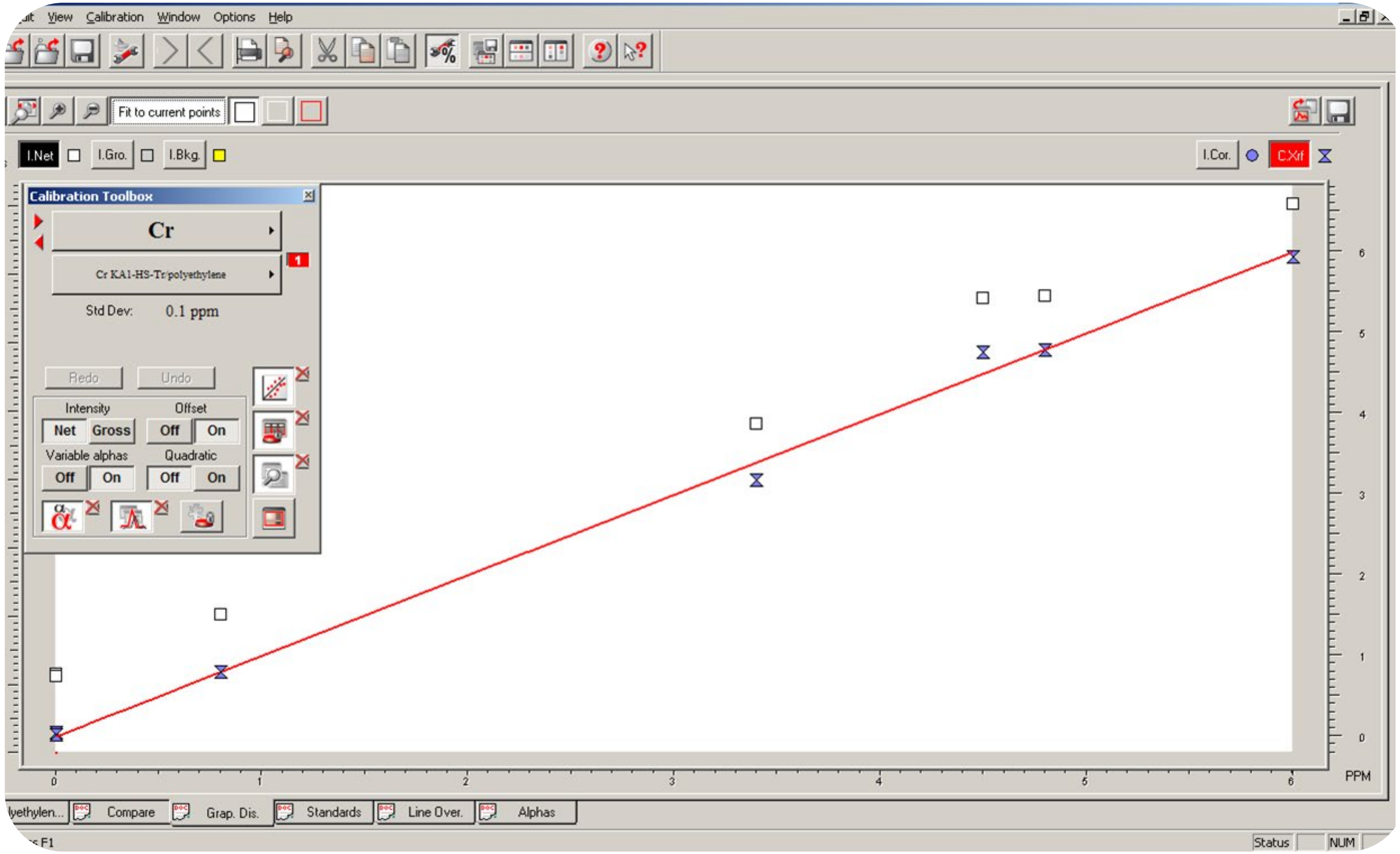
- Analysis of initiator residues
  - Mg beside high Al concentration in Ziegler-Natta Systems
  - Cr or Ti in 3d-element based initiator system
- Early recognition of initiator losses requires precise trace element determination
- Avoidance of high initiator concentrations in order to maintain long polymer life
- Meet regulation such as packaging directives, food safety and consumer product safety

Initiator Residues in PE
Analysis of Magnesium with the S8 TIGER



- Impurity from production
- Efficiency improved by reduced Mg concentration
- LLD: 0.2 ppm Mg

Initiator Residues in PE
Analysis of Chromium with the S8 TIGER



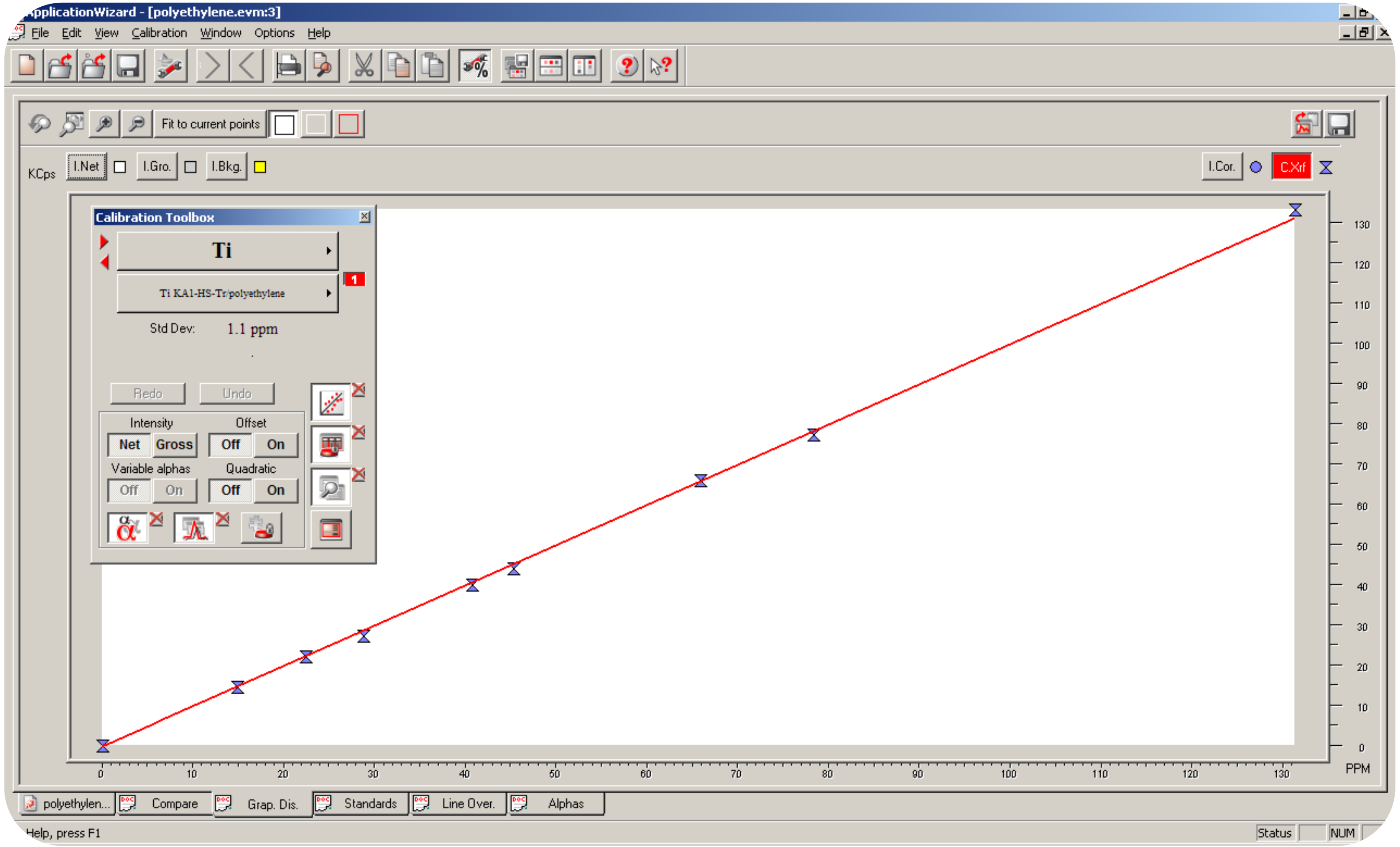
- Calibration Std. Dev. of 0.1 ppm
- Dedicated concentration range to max. 6 ppm Cr for optimal trace detection

Initiator Residues in PE
Analysis of Chromium with the S8 TIGER

- Optimal accuracy of less than 0.3 ppm deviation allows early recognition of initiator losses
- Detection limit of 0.2 ppm (3 σ, 60 s)
- Excellent precision
- Dedicated trace calibration enhances WDXRF performance
- Unrivalled accuracy of WDXRF in comparison to other methods such as ICP or AAS – due to little sample preparation

Number	Standard Name	Chemical Concentration	XRF Concentration	Absolute Deviation	Relative Deviatio	LLD (PPM)
1	CR1	0.8	0.8	0		0.2
2	CR2	3.4	3.2	-0.2		0.2
3	CR5	4.5	4.8	0.3		0.2
4	CR4	4.8	4.8	0		0.2
5	CR3	6	5.9	-0.1		0.3

Initiator Residues in PE
Analysis of Titanium with the S8 TIGER



- Calibration Std. Dev. of 1 ppm
- Dedicated concentration range to max. 200 ppm Ti

Initiator Residues in PE
Analysis of Titanium with the S8 TIGER

- Direct analysis of solid samples (disks - PUK) from a hot press or as granules
- Detection limit of 0.3 ppm (3 σ, 60 s) for low ranges or 1 ppm for higher ranges
- 1 ppm deviation for higher concentration ranges

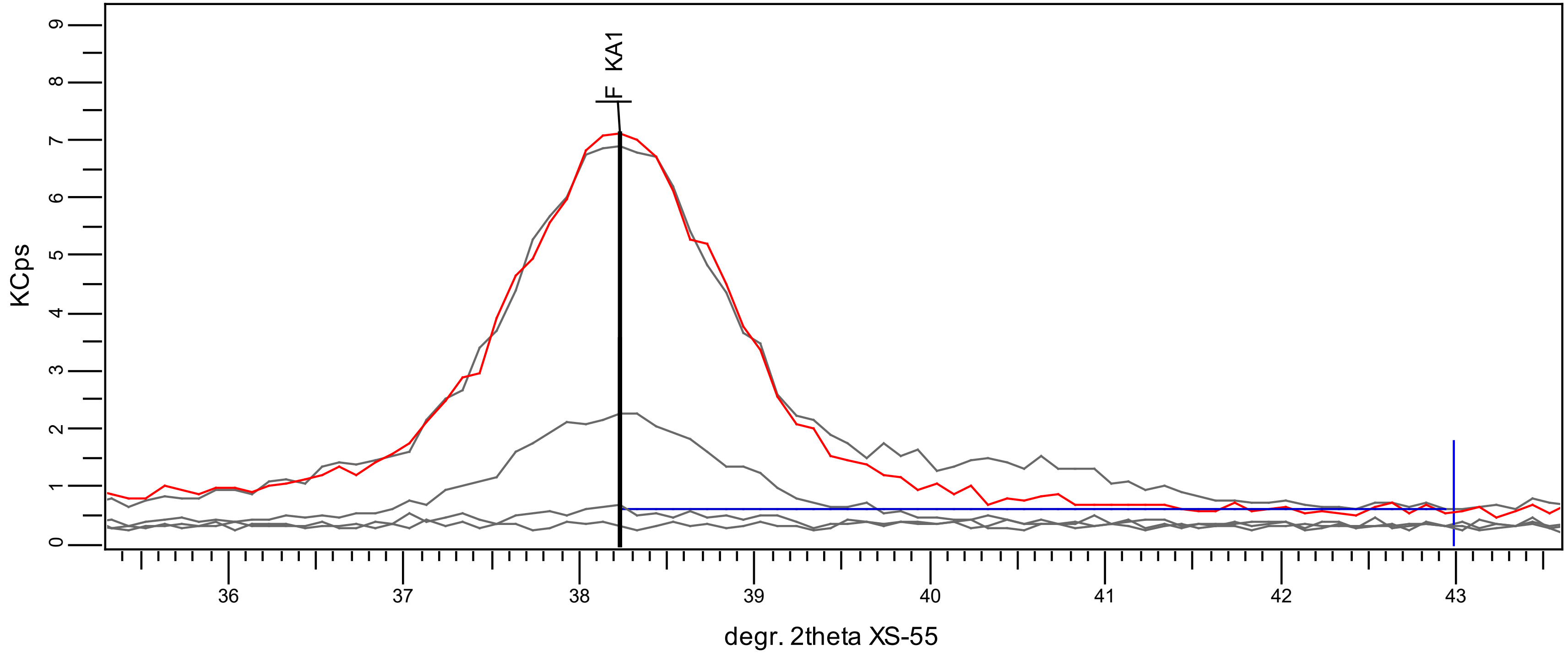
Number	Standard Name	Chemical Concentration	XRF Concentration	Absolute Deviation	Relative Deviation	LLD (PPM)
1	TITAN003	0.1	0	-0.1		0.2
2	TITAN009	14.9	14.4	-0.5	-3.3	0.3
3	TITAN019	22.4	22.1	-0.3	-1.1	0.4
4	TITAN023	28.8	27.1	-1.7	-5.8	0.5
5	TITAN034	40.8	39.9	-0.9	-2.3	0.6
6	TITAN038	45.3	44	-1.3	-2.9	0.7
7	TITAN048	65.9	65.9	0	-0.025	1
8	TITAN052	78.3	77.2	-1.1	-1.4	1
9	TITAN061	131.3	133.1	1.8	1.4	1

S8 TIGER
Analysis of Impurities

- Impurities from the production process influences polymer quality, such as iron and other elements from steel used for the piping and machineries

- Halogens decrease polymer life
- In solid samples the detection of F is possible with WDXRF in hot pressed samples

Impurities in PE
Analysis of Fluorine with the S8 TIGER



- Separation of F Kα from neighboring peaks, such as Fe L
- Use of the high resolution crystal XS-55 (multilayer optic)

Impurities in PE
Analysis of Fluorine with the S8 TIGER

- Direct analysis of solid samples (disks - PUK) from a hot press in vacuum
- Analysis of granules in polymer cups is not feasible due to absorption of F Kα in the foil
- Detection limit of 13 ppm F
- Excellent precision

Number	Standard Name	Chemical Concentration	XRF Concentration	Absolute Deviation	Relative Deviation	LLD (PPM)
1	F1	0	-1	-1		11.7
2	F2	1630	1904	274	17	12
3	F3	3418	4667	1249	37	12.9
4	F4	4378	4424	46	1	12.8
5	F5	6543	6264	-279	-4	13.3
6	F6	7444	6400	-1044	-14	13.4
7	F7	10238	10409	171	2	15.2

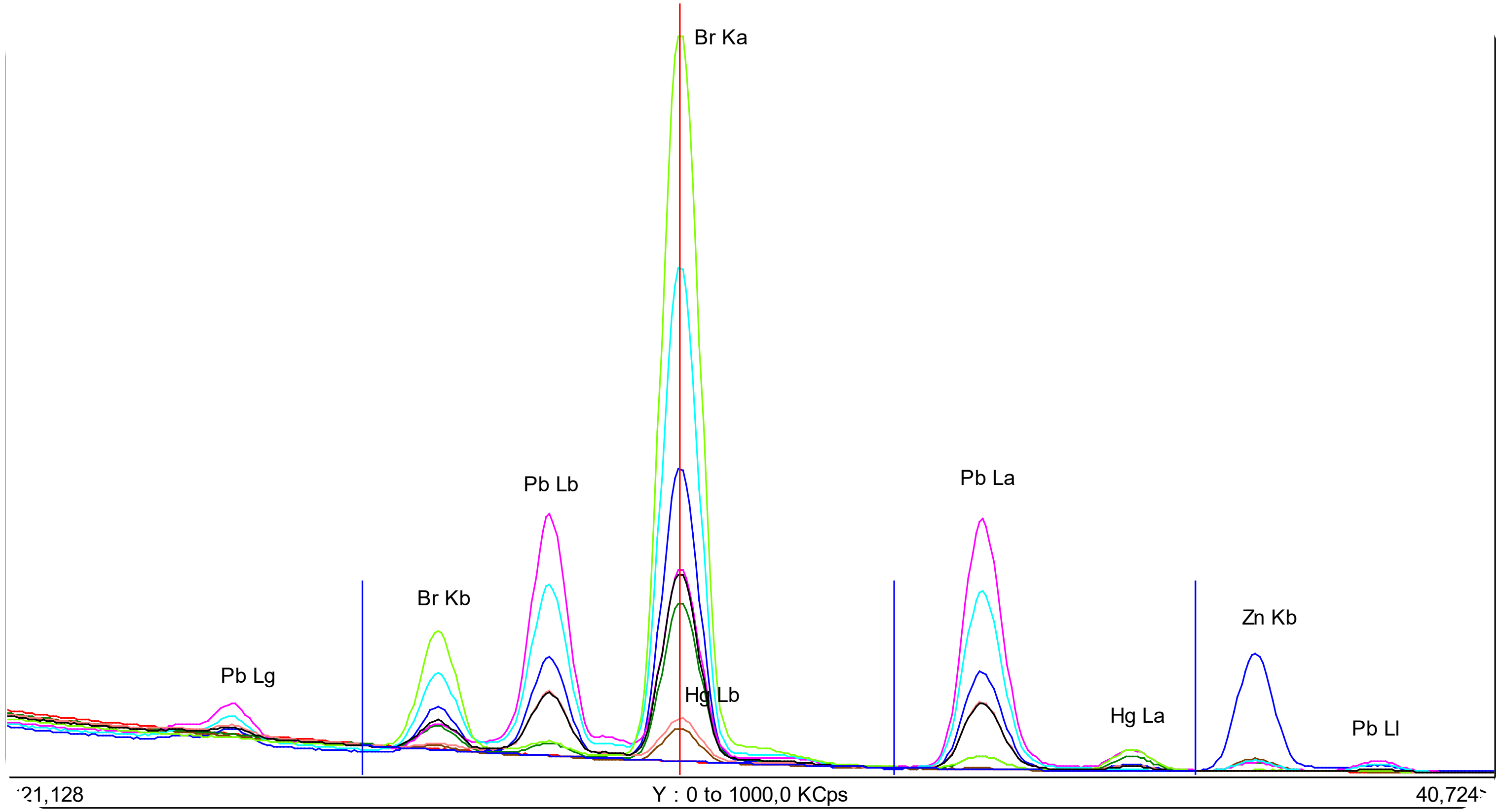
WDXRF
Analysis of Regulated Hazardous Elements

- Detection and analysis of regulated toxic elements are possible with WDXRF down to the sub-ppm range

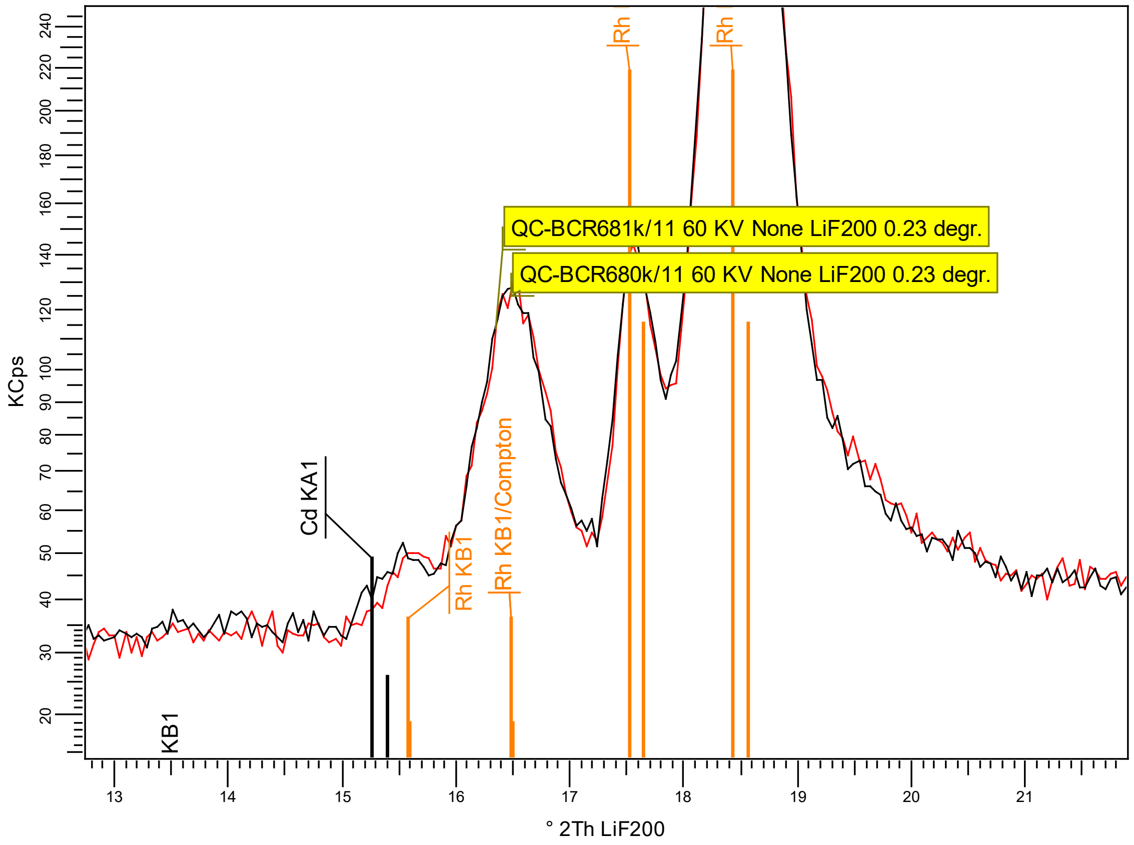
- EDXRF is not capable of separating elements such as Hg, Br and Pb from each other
  - Low spectral resolution

Regulated Toxic Elements
Analysis of RoHS Elements with the S8 TIGER

- Optimal resolution
- WDXRF separates neighboring lines
- Clear identification of Hg, Pb, and Br



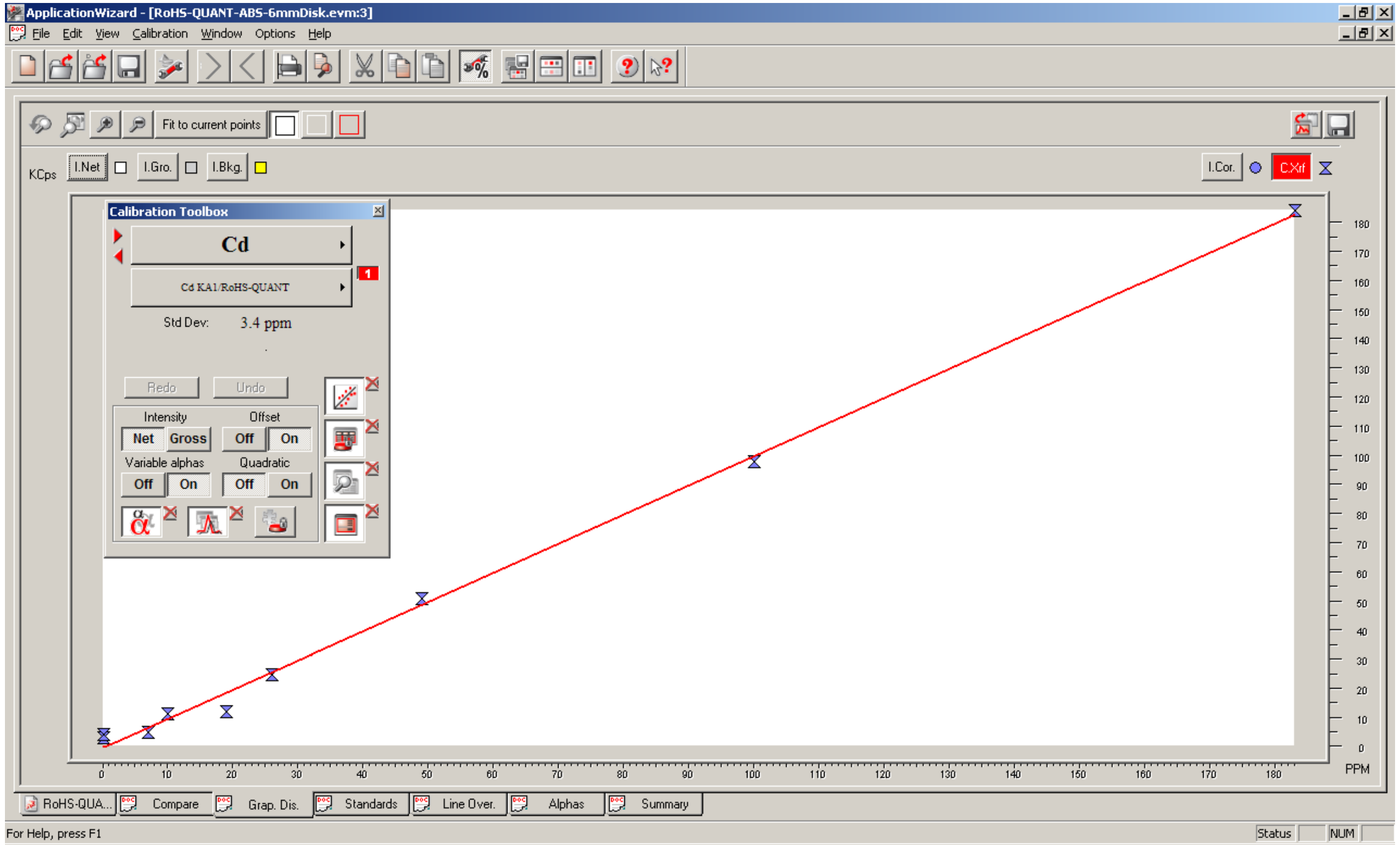
Regulated Toxic Elements
Analysis of Cadmium with the S8 TIGER



- Separation of Cd from tube lines (Rh Kα for the S8 TIGER) with LiF 200, better with LiF 220

Regulated Toxic Elements
Analysis of Cadmium with the S8 TIGER

- Calibration range up to 200 ppm Cd
- Calib. Std. Dev. of less than 4 ppm
- High linearity



Regulated Toxic Elements
Analysis of RoHS Elements with the S8 TIGER

Sample	Date	Cr (%)	Br (%)	Hg (%)	Pb (%)	Cd (%)
Average (n=83)	every 10 min	0.0479	0.0346	0.0288	0.0333	0.0017
Stdev		0.0002	0.0005	0.0001	0.0001	0.0001
COV		0.5%	1.4%	0.4%	0.4%	6.0%

QC_RoHS-QUANT-ABS-6mmDisk	12/10/2008 9:18	503	227	95	401	475
QC_RoHS-QUANT-ABS-6mmDisk/1	12/10/2008 9:27	504	227	95	402	473
QC_RoHS-QUANT-ABS-6mmDisk/2	12/10/2008 9:36	503	227	93	403	474
QC_RoHS-QUANT-ABS-6mmDisk/3	12/10/2008 9:45	504	227	93	400	474
QC_RoHS-QUANT-ABS-6mmDisk/4	12/10/2008 9:54	503	227	92	402	474
QC_RoHS-QUANT-ABS-6mmDisk/5	12/10/2008 10:03	504	226	94	401	474
QC_RoHS-QUANT-ABS-6mmDisk/6	12/10/2008 10:11	504	226	95	401	475
QC_RoHS-QUANT-ABS-6mmDisk/7	12/10/2008 10:20	503	227	94	403	475
QC_RoHS-QUANT-ABS-6mmDisk/8	12/10/2008 10:29	505	227	97	402	476
QC_RoHS-QUANT-ABS-6mmDisk/9	12/10/2008 10:38	504	226	96	402	475
QC_RoHS-QUANT-ABS-6mmDisk/10	12/10/2008 10:47	504	227	94	400	476
QC_RoHS-QUANT-ABS-6mmDisk/11	12/10/2008 10:56	503	227	94	400	473
QC_RoHS-QUANT-ABS-6mmDisk/12	12/10/2008 11:05	504	226	96	401	474
Average		**504**	**227**	**94**	**401**	**475**
Std.Dev.		**1**	**0**	**1**	**1**	**1**
Rel.Std.Dev.		0.14%	0.20%	1.32%	0.26%	0.17%

- Excellent precision of less than 1.5 % relative in ppm levels

WDXRF Performance
S8 TIGER

- Accuracy and precision fit to demands for the analysis of
  - Additives
  - Initiator residues
  - Impurities
  - Regulated elements
- Simple sample preparation
  - For integration into process control regime and quality checks close to production
- Detection of traces to sub-ppm with standard instrument configuration
- Ready to analyze solutions available

BRUKER's Strength
Complete Product Range for Polymers

From Dedicated Performer to a full versatile XRF for all

S2 POLAR:

- Compact instrument with very low LLD for lighter elements

S2 PUMA:

- Versatile Benchtop XRF for broader applications

S6 JAGUAR:

- Benchtop WDXRF with high resolution for difficult applications, but few samples per day

S8 TIGER:

- Versatile instrument for all applications, incl traces

XRF – the most versatile, flexible and fast Method

- Direct analysis of liquids and solids w/o sample prep
- Down to sub ppm levels of hazardous elements and important traces, such as Cl or Ti
- High precision for additives, less than 1 % relative
- High flexibility for almost the entire PSE
- Ready for future tasks, e.g. food packaging, TiO_2,…



Any Questions?

Learn more about New XRF Technologies –
How latest developments boost XRF with new materials & components for better analytical performance
In our 23.6.2021 webinar – Sign Up Now!

Thank you!

Kai Behrens Frank Portala Adrian Fiege

Innovation with Integrity