Automation in Sampling and Analysis at UPMR

LBMA Assaying & Refining Conference
12-15 March 2023

Agenda

- Introducing Umicore / UPMR
- Automation in final sample preparation
- Automation in the analytical laboratory
  - Flux dispensing
  - Automated weighing
  - Pyrosulfate fusion
  - Spark-OES

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Introducing Umicore

Who we are

We deliver sustainable solutions to address global megatrends.

Our products and services accelerate global **mobility transformation**, cater for the **growing need for advanced materials** and enable **even greater circularity for critical metals**.

We are the leading ***circular* materials technology company** fulfilling its mission to create sustainable value through
materials for a better life

Introducing Umicore

A global materials technology and recycling group

One of three global leaders in emission control catalysts for light-duty and heavy-duty vehicles and for all fuel types

A leading supplier of key materials for rechargeable batteries used in electrified transportation and portable electronics

The world's leading recycler of complex waste streams containing precious and other valuable metals

Our Group structure

CATALYSIS

Automotive Catalysts

Precious Metals Chemistry

Fuel Cell & Stationary Catalysts

ENERGY & SURFACE TECHNOLOGIES

Rechargeable Battery Materials

Cobalt & Specialty Materials

Metal Deposition Solutions

Electro-Optic Materials

RECYCLING

Precious Metals Refining

Precious Metals Management

Jewelry & Industrial Metals

Battery Recycling Solutions

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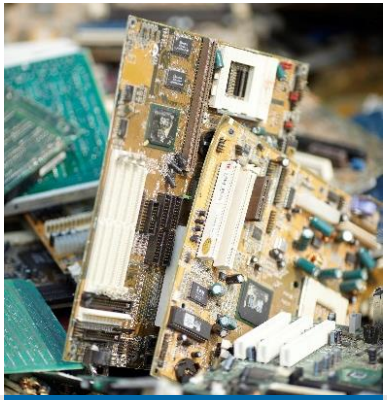
Introducing Umicore Precious Metals Refining

Introducing UPMR

The leading precious metals recycler

Largest and most complex precious metals recycling operation in the world



Processes more than 200 different types of raw materials

World leading refiner of 17 different metals

World class environmental and quality standards

Refining @ UPMR

Core business components

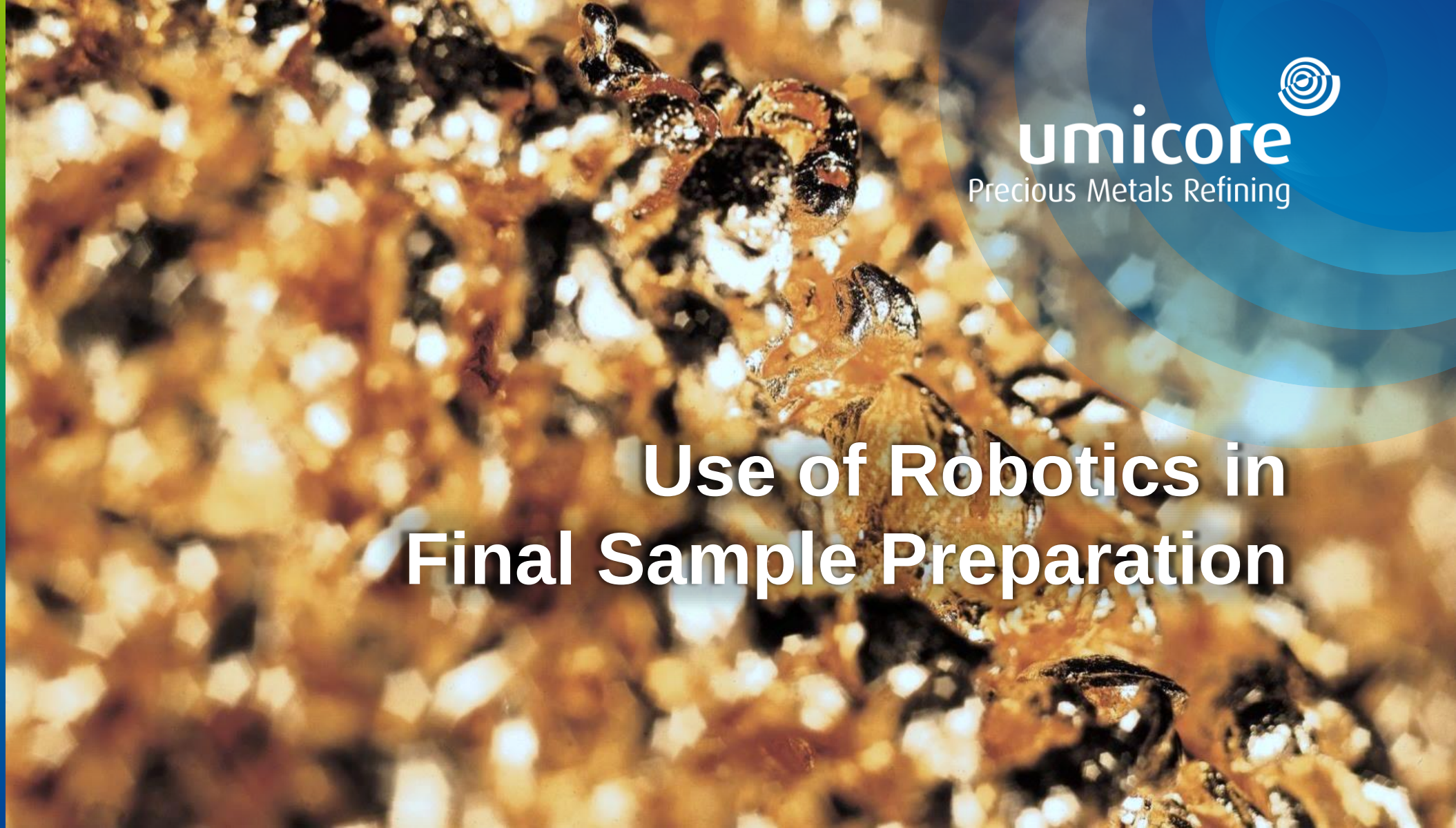
Raw materials supply

Sampling & assaying

Smelting & refining

Metal sales

CUSTOMER SUPPORT



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Use of Robotics in Final Sample Preparation

Sampling @ UPMR

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Metallic material

- Sample composition
- Melting in induction furnace
- Dip sampling of molten material
- Sawing of dip samples

- Milling and screening
- Final sample for assaying

Electronic scrap

- Shredding to 40 x 40 mm
- Primary sampling (400 kg)
- Shredding primary sample
- Secondary sampling by tube divider
- Proportional composition (coarse-dust)
- Incineration of composed sample
- Separation coarse and fines
- Milling and screening of fines
- Melting of coarse fraction by adding aluminium

- Milling and screening
- Final sample for assaying

Lumpy material

- Primary sampling by scoop or shovel
- Jaw crushing of bulk sample
- Secondary sampling
- Milling in pan mill and screening
- Reduction by tube divider
- Proportional composition

- Milling and screening
- Final sample for assaying

Fine free flowing material

- Homogenising by bi-conical blender
- Automated sampling by rotating sampler
- Homogenising of primary sample in small bi-conical blender ($1m^3$)
- Automated sampling by rotating sampler
- Moisture determination
- Proportional composition

- Milling and screening
- Final sample for assaying

Wet material

- Automated spear sampling
- Homogenising by means of industrial mixer
- Dip or spear sampling of mixed primary sample
- Determination of moisture
- Proportional composition

- Milling and screening
- Final sample for assaying

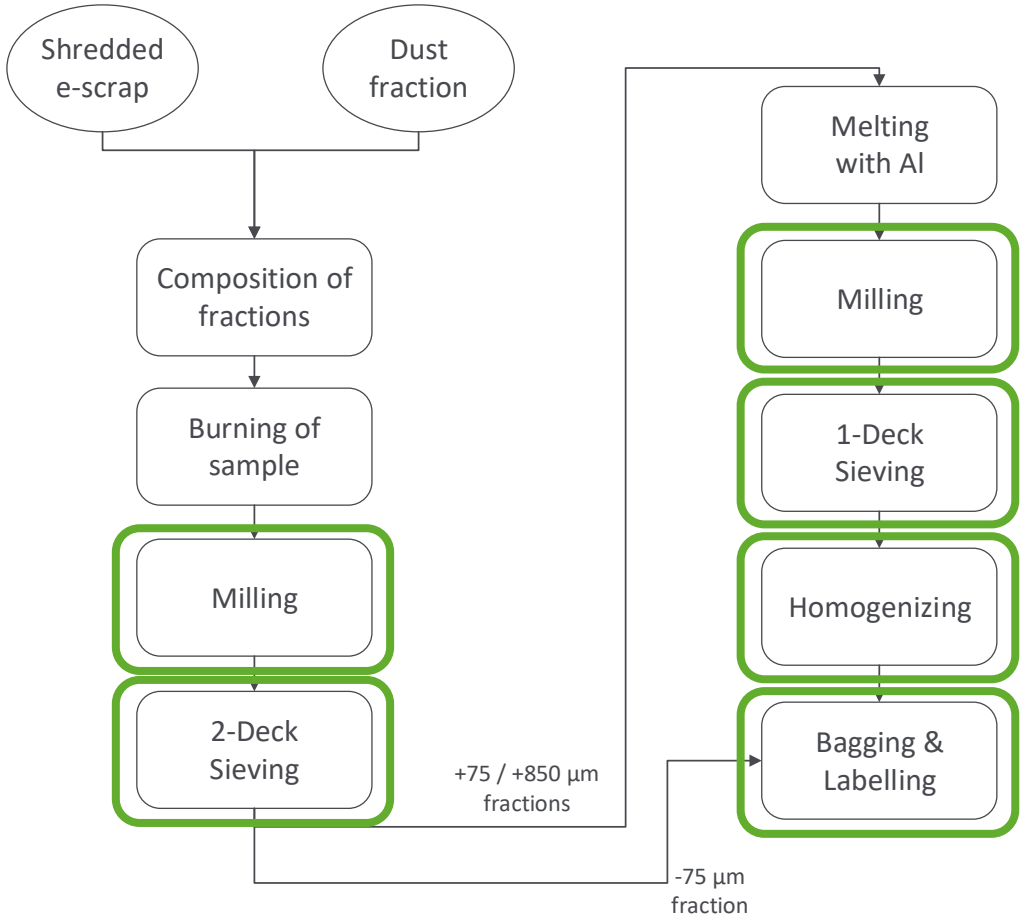
Automotive catalysts

- Decanning
- Crushing of broken monolith in ball mill or blending of milled material
- Primary sampling
- Blending and secondary sampling
- Moisture determination
- Proportional composition (fines/dust)

- Milling and screening
- Final sample for assaying

Use of Robotics in Final Sample Preparation

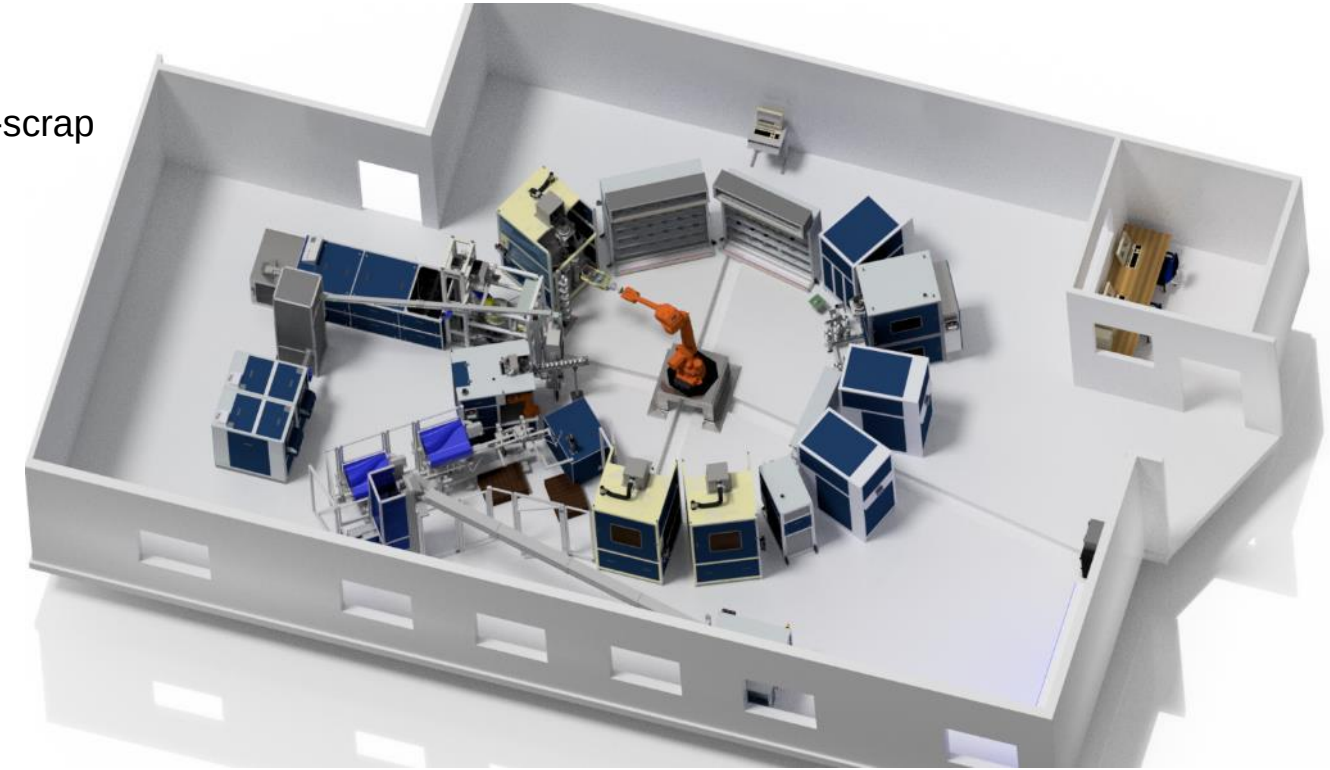
Flow of Final Sample preparation for e-scrap



Use of Robotics in Final Sample Preparation

Overview of the setup

1. Central Robot arm
2. Input magazine for burnt e-scrap
3. Continuous mill
4. 2 Deck sieve
5. Magazines (In & Out)
6. Crusher – Splitter
7. Mills
8. 1 Deck sieves
9. 2 way splitter
10. 16 way splitter
11. Bagging
12. Labelling
13. Bagging Magazine



E-scrap

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Round up

Points of attention

- Sampling setup:
  - Dust → additional (manual) cleaning steps required
    - Metallic dust → short circuit
  - Humidity → “sticking” of material

- Next steps
  - Preventive / predictive maintenance?
  - Temperature sensors to detect temperature increase of fine metallic powders

- General points of attention:
  - High investment cost
  - Intensive and time consuming research (3 – 5 years)
  - Automation in sampling only makes sense when there is enough volume
  - Learning curve to increase the flexibility of the Automation (cleaning cycles,…)
  - Need for higher skilled staff

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Use of Robotics in the analytical laboratory

Flux dispensing

Project started in 2014 for the automatic dispensing of flux for Pb fire assay and NiS fusion

- Time consuming (150000 manual weighings)
- Repetitive task
- Health risks (PbO)

Flux dispensing

Flux dispensing

Achievements & challenges

- Main achievements
  - High capacity (1000 portions/day)
  - Fast dispense (30s)
  - 0,5g tolerance
  - Happy coworkers ☺
- Main challenge = robustness of the setup
  - Containment of PbO dust
  - Supply of paper cups (critical dimensions)
  - Vibrations & dusts leads to defects (lifting mechanism, balance, contacts, …)

Automated sample weighing

Project started in 2018 for automatic sample weighing

- Repetitive tasks
- High throughput of samples (45000 replicates)
- Output trays per analytical method / operational section
- Simultaneous moisture determination

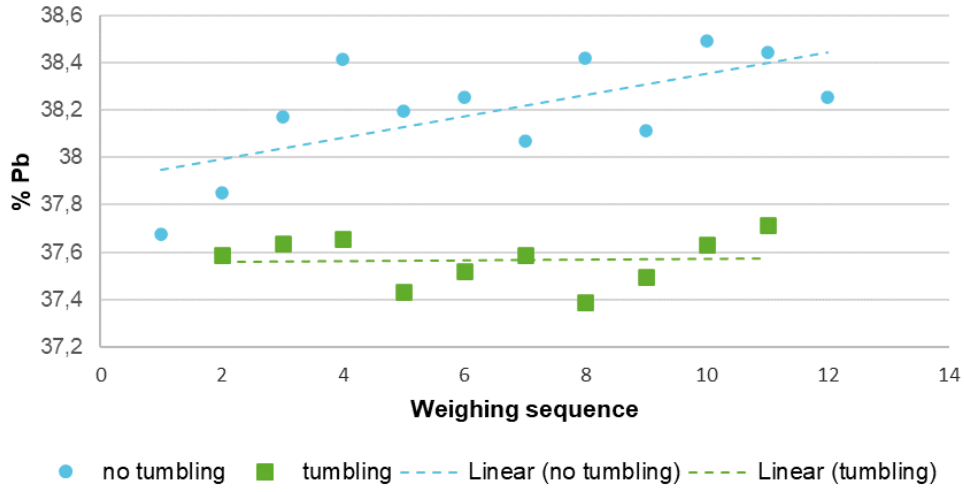
Automated weighing

Automated weighing

Achievements & challenges

- Main achievements
  - Accurate sample weighing 0,25 – 10 g
  - Dual tilt & turn dispense setups for maximal output up to 500 weighings / day
  - 150 input samples
  - Simultaneous moisture determination

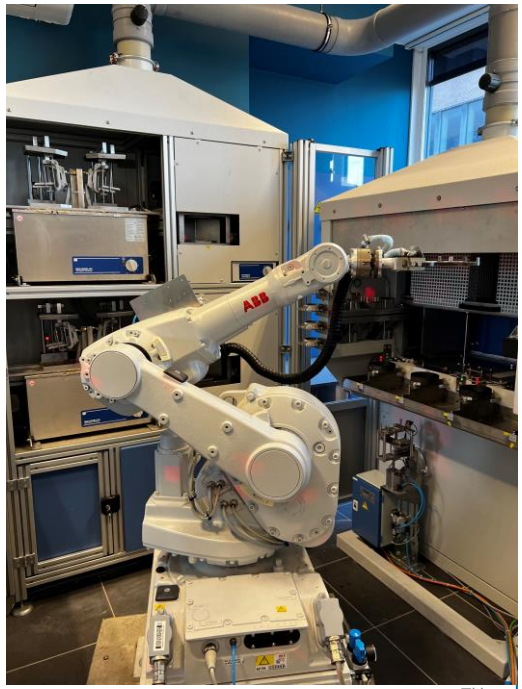
- Overcome challenges:
  - Cross-contamination
    - Samples in separate tubes
    - Tilt and turn
  - Segregation
    - Tumbling



Pyrosulphate automation

Project started in 2020 for the automatic preparation of pressed pellets for XRF

- High throughput (22000 pressed pellets)
- Improved quality robustness
  - Speed of pouring, furnace temperature, residence time, …



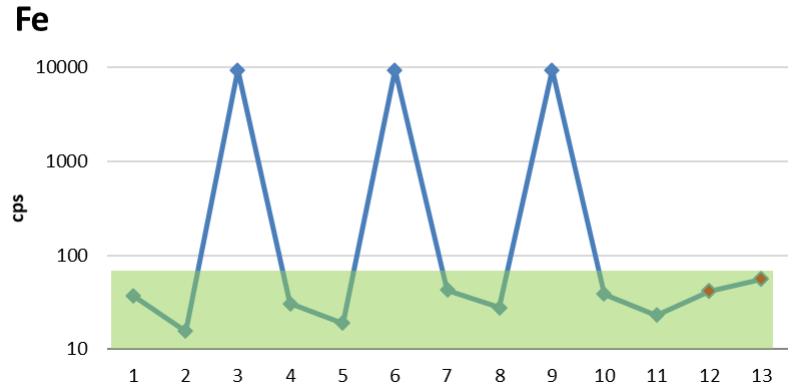
Pyrosulphate automation

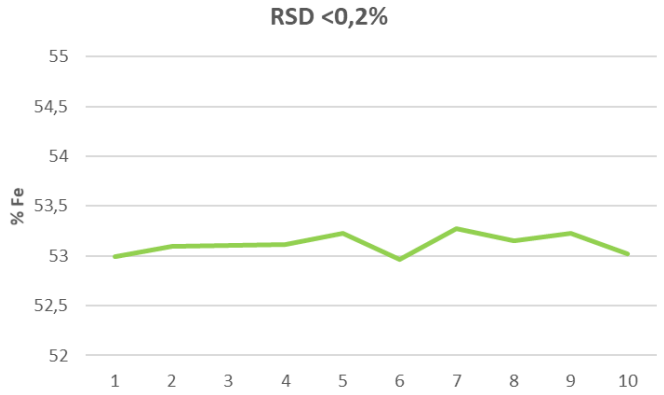
Pyrosulphate automation

Achievements & challenges

- Main achievements:
  - 60 samples / run
  - Ultrasonic cleaning of crucibles
  - Graphite moulds → quantitative recovery
  - Automated additions in disc mill
    - Wax
    - Water
    - Sand
    - Ethanol
  - Sample identification print

- Overcome challenges
  - Cleaning disc mill
    → tungsten carbide vs stainless steel
  - Reproducibility





Automated spark-OES

3 Projects realised in 2011, 2018 and 2020 for the automated measurement of Pb-buttons

- Health (Pb)
- Labour intensive (milling) / time-consuming (measurements)

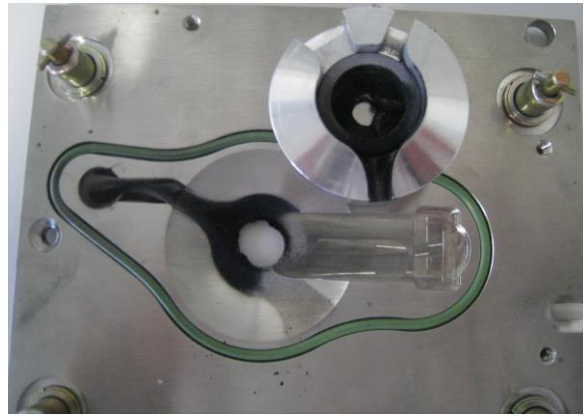
Automated spark-OES

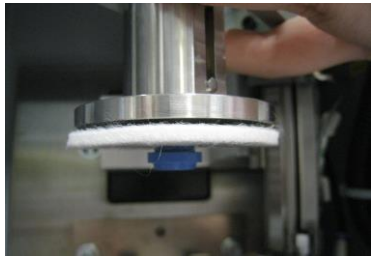
Automated spark-OES

Achievements & challenges

- Main achievements:
  - Automated setup with automatic re-calibration
  - Sample / standard rack for 24 standards and 120 samples
  - Surface milling
  - Visual crack detection
  - Sample identification (punch marker)

- Challenges
  - Production / consumption of standards
  - Pb dust contamination
    → Cleaning of the spark stand





Thank you

Questions?

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