25 - 27 October / Ekim 2018
TÜYAP Fair, Convention & Congress Center, İstanbul
Tüdöksad Akademi 10. Uluslararası Döküm Kongresi / 10th International Foundry Congress by Tudoksad Academy
In conjuction with ANKIROS / ANNOFER / TURKCAST fairs

«Vmet Analysis of Aluminium Alloys, Principles, Applications and Statistics»

«Alüminyum Döküm Alaşımlarının Vmet Analizi, Temel Kavramı, Uygulanması ve İstatiksel Değerlendirmeleri»

Wenwu Shi (Foseco)

6.Oturum / 6th Session

Oturum Başkanı / Session Chairman: Prof. Dr. Ali Kalkanlı (ODTÜ)

TÜDÖKSAD

tüdöksad akademi


FOSECO
FOSECO

Vmet Analysis of Cast Aluminium Alloys, Fundamental, Application and Statistical Analysis

October of 25th – 27th 2018
ANKİROS

Martın Freyn
CEME Product Manager

FOSECO

Melih Evirgen
NF Application Engineer

Agenda

JUST

ADD

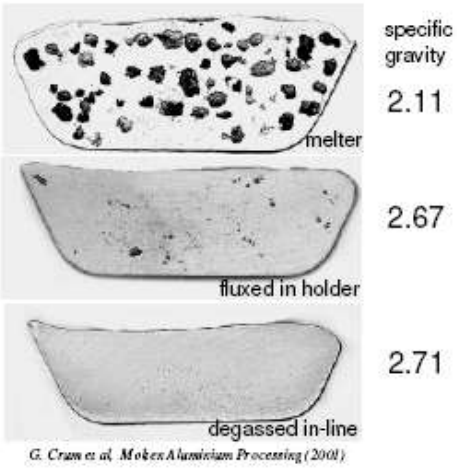
FOSECO

- Methods of melt cleanliness evaluation
  - RPT
  - PoDFA, Prefil-footprinter, …….
- Vmet (**V**esuvius **M**etal Quality **A**nalysis) – Aspex
  - Application in foundry
  - K mould
  - Results evaluation
- Summary

Melt Quality Control - Reduced Pressure Test

- The Reduced Pressure Test (RPT) is one of the most common methods of determining the hydrogen level

  - Prediction of relative probability of porosity formation
  - Measurement results can be influenced by
    - Other gas sources than hydrogen, i.e. entrapped air (bi-films)
    - Non-metallic inclusions
  - Manual sampling, result available only with time delay



G. Crum et al. Molten Aluminium Processing (2001)

simple system for specific gravity measurement

tsc Aluminium Degassing

FOSECO

Melt Cleanliness Measurement

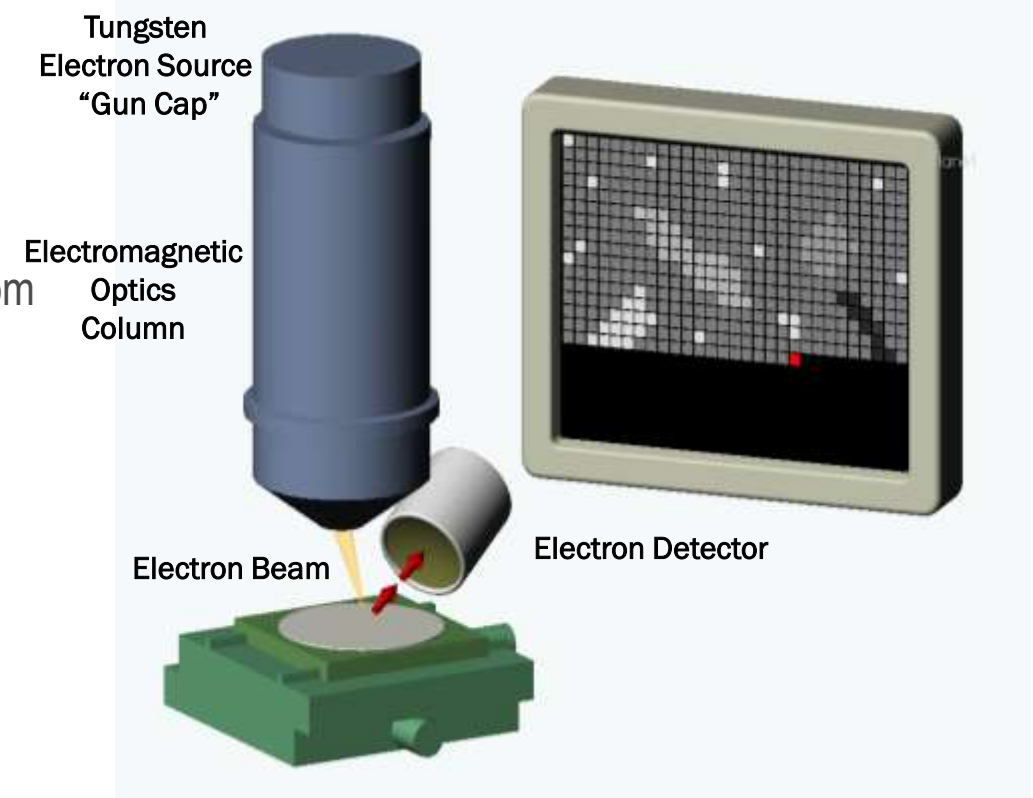
- **PoDFA (Porous Disc Filtration Apparatus)**
- **LAIS (Liquid Aluminium Inclusion Sampling)**
  - Manual sampling
  - Off-line quantitative inclusion analysis by metallography
  - Identification of inclusions, time consuming procedure
- **LIMCA (Liquid Metal Cleanliness Analyzer)**
  - In-line measurement
  - On-line quantitative measurement of inclusion number
  - No identification of inclusions, fast procedure
- **Prefil Footprinter (Pressure Filtration)**
  - Direct assessment of melt cleanliness
  - Quantitative inclusion analysis possible
- **Acoustic/ultrasound measurement methods**

FOSECO

ASPEX® MQA™ Inclusion Analysis

What is an SEM?

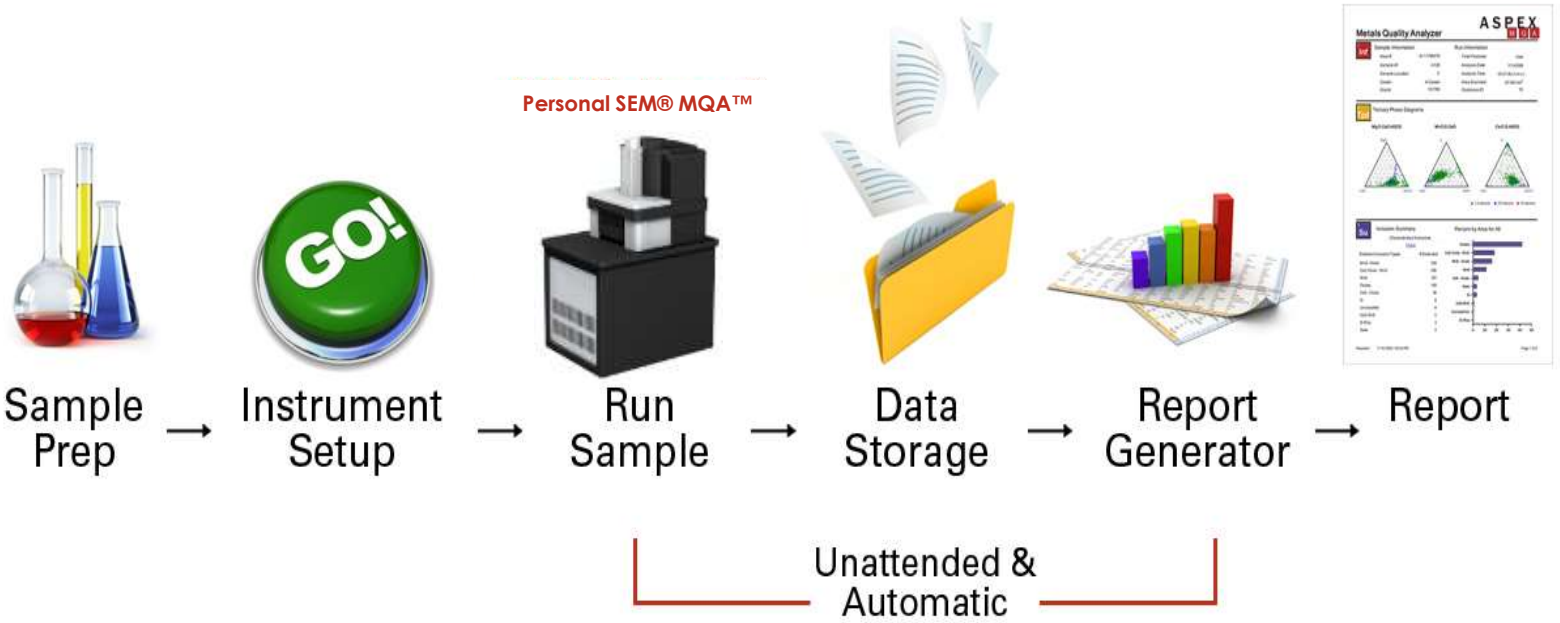
- A scanning electron microscope imposes electrons onto a sample
- An electron detector receives a signal from the sample
- Energy dispersive X-ray spectrometry (EDS) identifies compositional changes
- Manual SEM operation identifies one inclusion at a time



FOSECO

ASPEX® MQA™ Inclusion Analysis

What is ASPEX MQA?

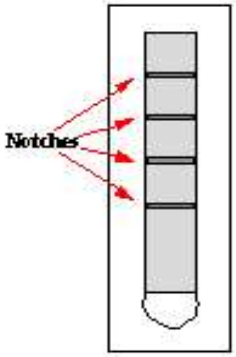


- ASPEX Corporation manufactures scanning electron microscopes (SEM) with advanced integration technology to maximize efficiency of analysis
- Metals Quality Analyzer (MQA) is their software and hardware solution that differentiates features by size and composition with automatic reports
- Feature compositions are plotted on several ternary phase diagrams on the front of the MQA report
- Automatic scanning yields over 1000 features per hour, which is more than 200x faster than
- traditional manual SEM operation

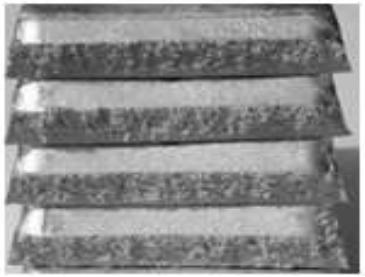
FOSECO

ASPEX / V-met analysis - K-Mould

Measures coarse inclusions.
Series of notches
Fracture
Examine for inclusions



K Factor 2.2



K Factor 0.2

FOSECO

ASPEX / Vmet investigation on K-mould sample

As melted

After transfer

After MTS 1500 treatment

FOSECO

ASPEX / V-met analysis – samples from Kmould or casting

Samples from Kmould

Last cube of Kmould or by customer defined area is dedicated for an analysis

Samples from casting

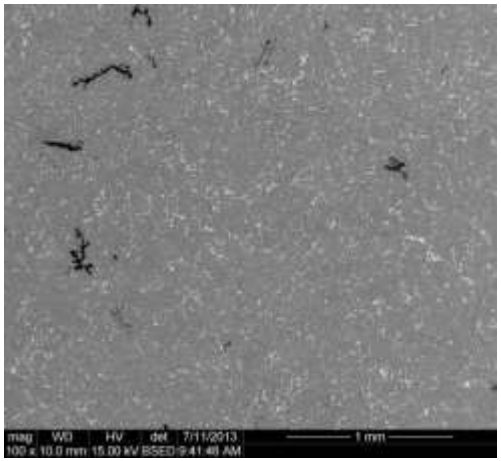
FOSECO

ASPEX / V-met analysis – samples preparation

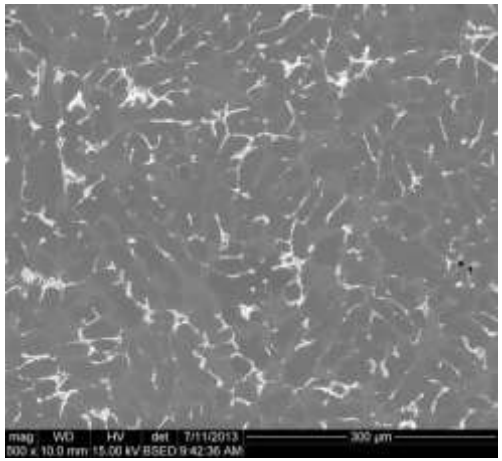
- The K-mould samples from this trial were cut to fit into 32 mm diameter sample cups, then mounted in heat set resin and polished using a Struers Hexamatic polisher.
- The polishing routine consisted of grinding with a SiC wheel for 30 seconds, followed by 9 micron diamond for 9 minutes and 3 micron diamond for 1:20 minutes. The final polish was done with 400 nm colloidal silica for 1 minute. An ultrasonic cleaning was performed between each step.
- Polished samples are evaluated using SEM analysis at magnifications of 100, 500, and 2000x to give a qualitative indication of the metal microstructure and porosity.
- Finally the samples were evaluated using Vmet automated SEM analysis which counts and classifies features by size and chemical composition.

FOSECO

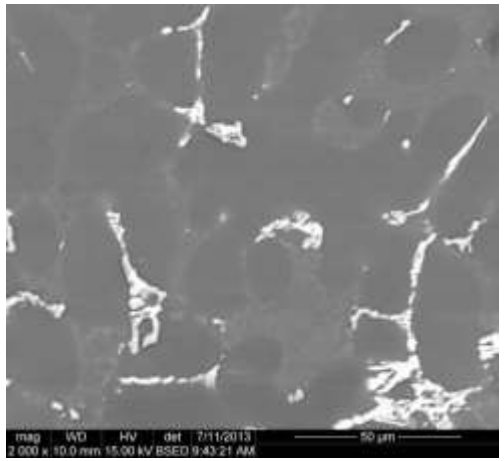
Vmet / SEM images of the polished K-mold sections at increasing magnification / A319



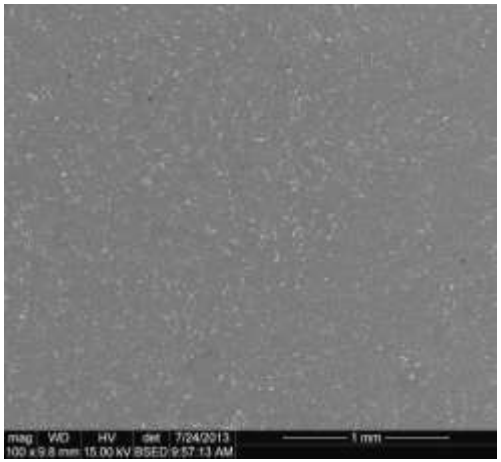
Sample 11 before tr. 100x



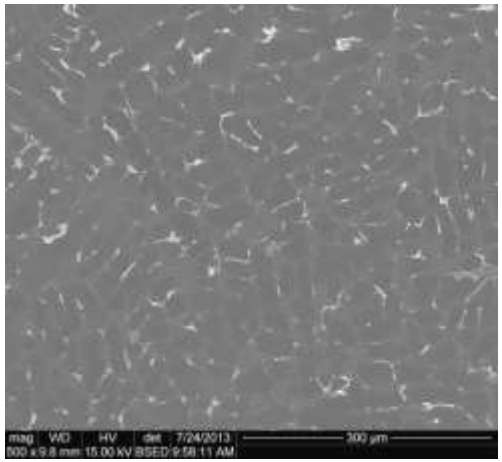
Sample 11 before tr. 500x



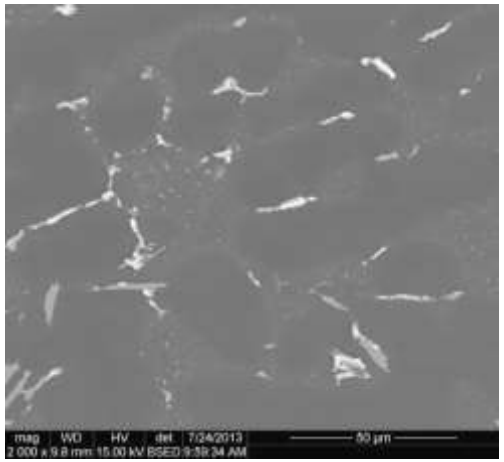
Sample 11 before tr. 2000x



Sample 12 after MTS 100x



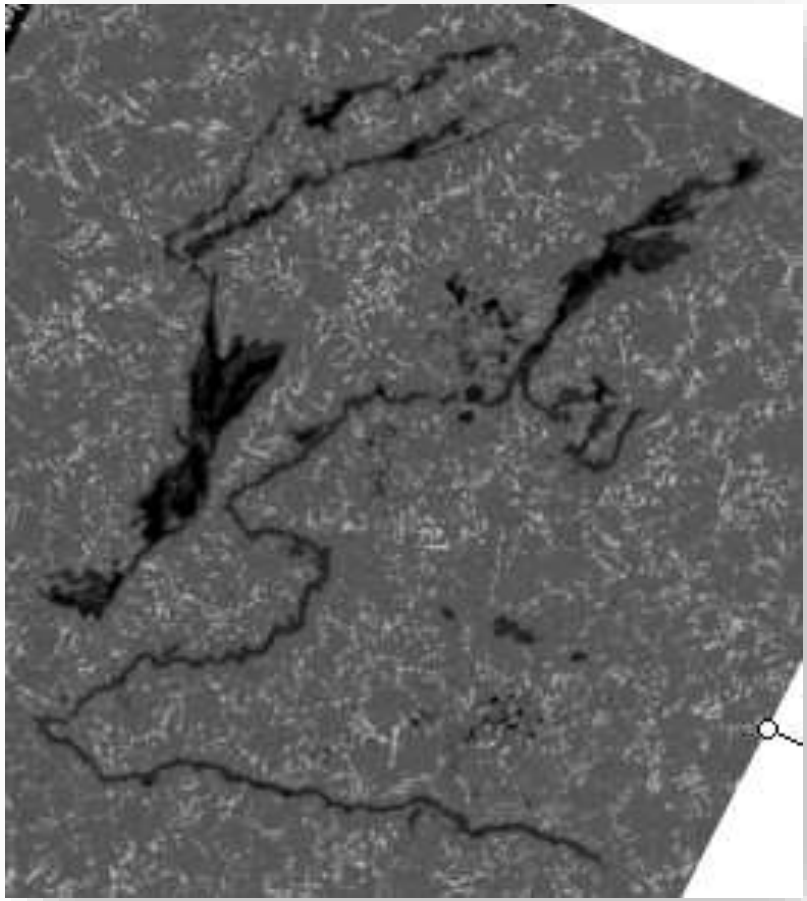
Sample 12 after MTS 500x

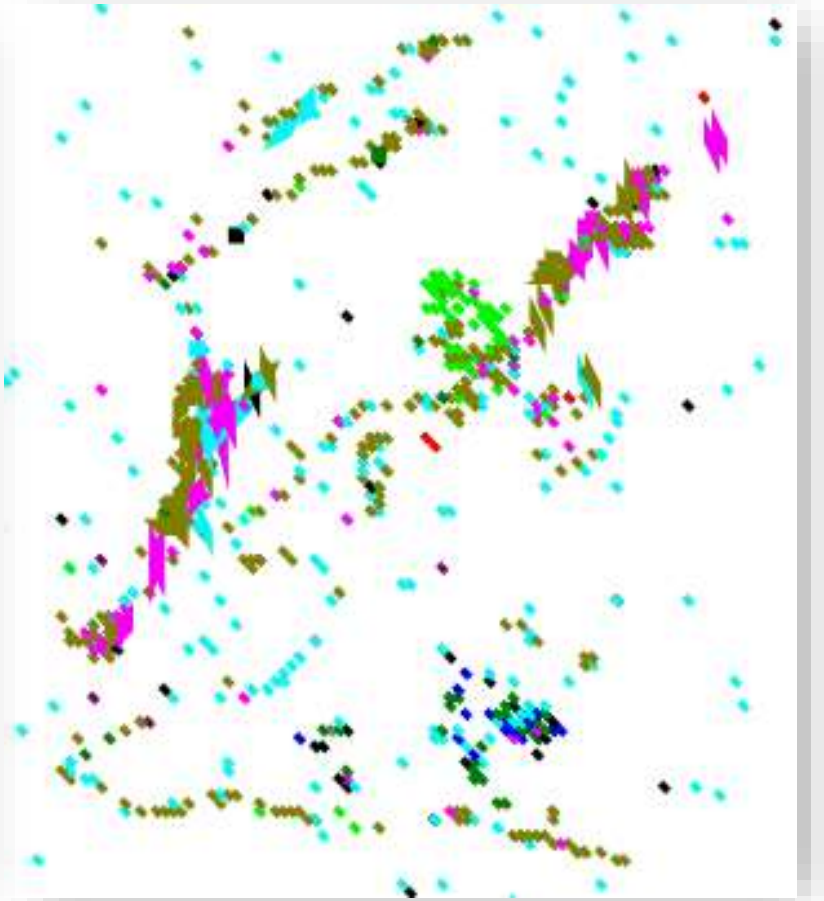


Sample 12 after MTS 2000x

FOSECO

ASPEX / V-met analysis – oxide cluster



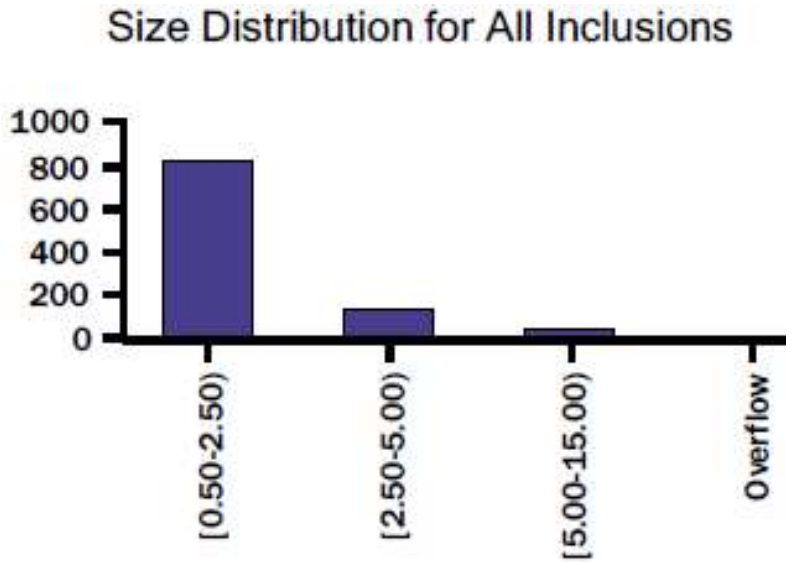


FOSECO

ASPEX® MQA™ - Vmet Inclusion Analysis

Size Distribution Table

Size Bins (mic	Number of Features All Features
[0.50-2.50)	820
[2.50-5.00)	126
[5.00-15.00)	40
Overflow	1



Example: Out of about 1000 inclusions, this sample had 40 features between 5 and 15 μm diameter, and one feature greater than 15 μm diameter

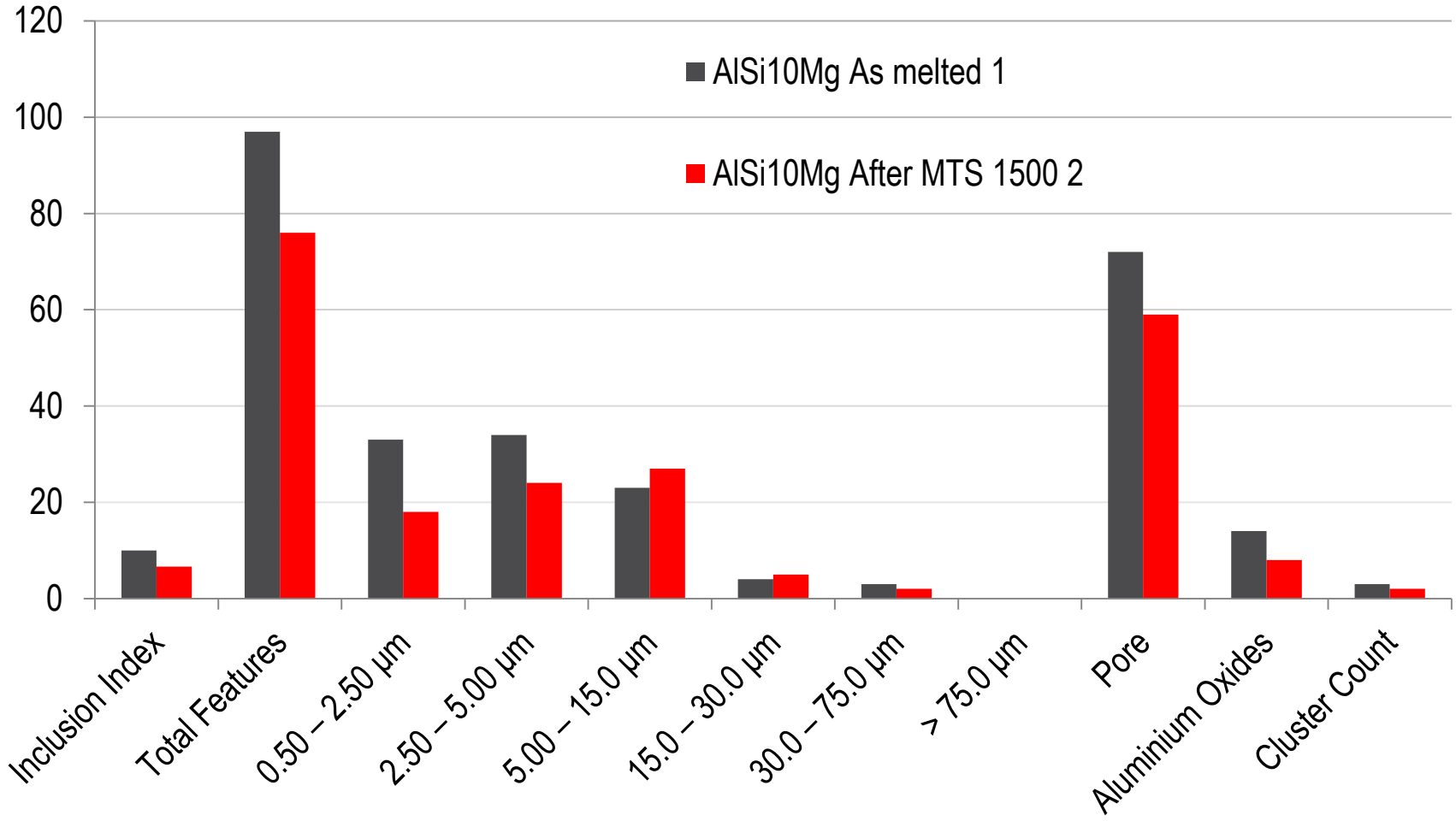
FOSECO

Vmet results – AlSi10Mg

	AlSi10Mg	AlSi10Mg	
	As melted	After MTS	% removal
Sample	3	4	
Inclusion Index	38.5	20.2	48%
Total Features	474	62	87%
0.50 – 2.50 µm	104	24	77%
2.50 – 5.00 µm	164	18	89%
5.00 – 15.0 µm	176	7	96%
15.0 – 30.0 µm	18	7	61%
30.0 – 75.0 µm	12	5	58%
> 75.0 µm	0	0	
Pore	327	50	85%
Al oxides	37	8	78%
Cluster Count	11	5	55%

FOSECO

Vmet results – AlSi10Mg



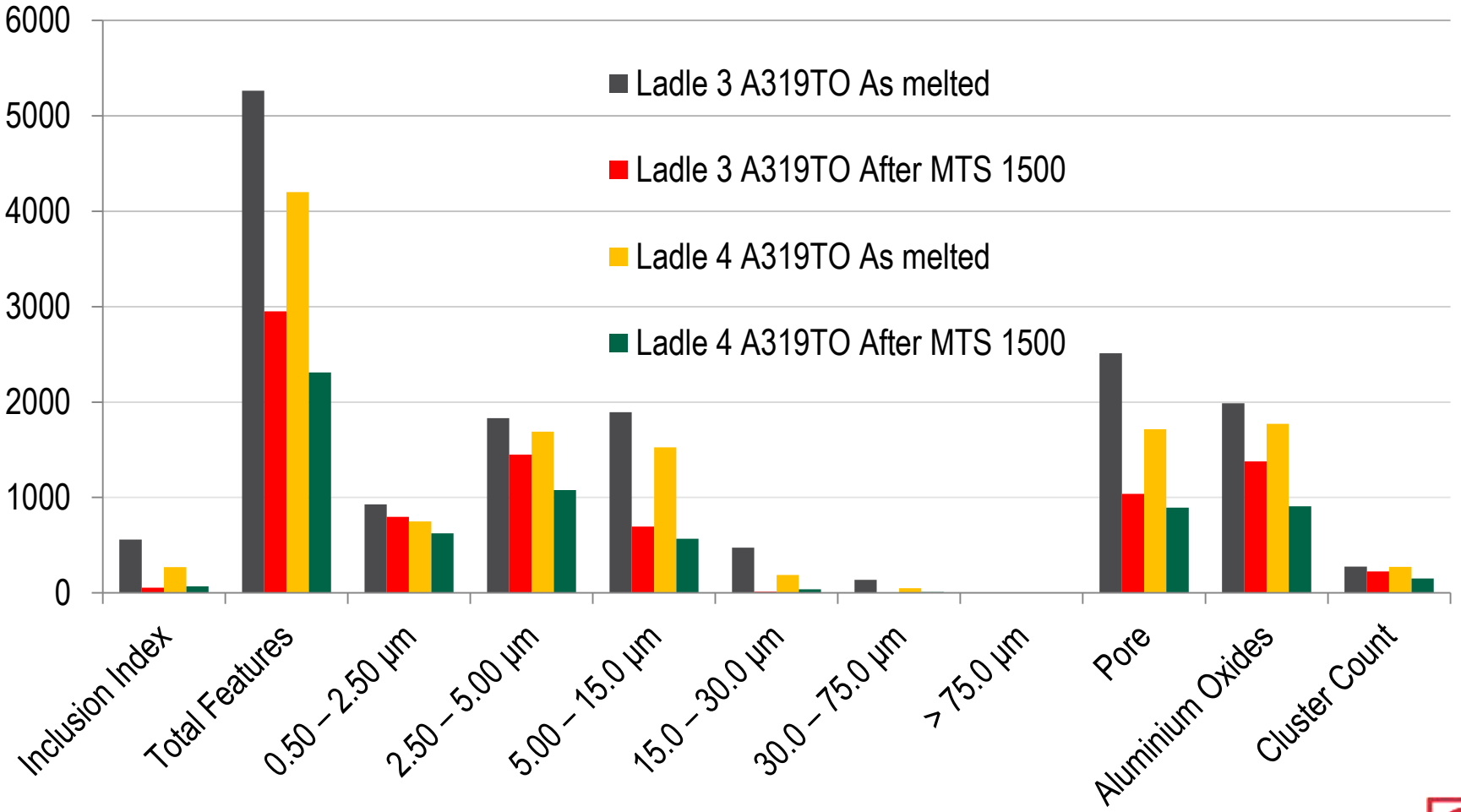
FOSECO

Vmet results – A319TO

	Ladle 3 A319TO	Ladle 3 A319TO		Ladle 4 A319TO	Ladle 4 A319TO	
	As melted	After MTS 1500	% removal	As melted	After MTS 1500	% removal
Sample	7	8		9	10	
Inclusion Index	559.4	55.1	90%	270.2	68.3	75%
Total Features	5265	2951	44%	4200	2309	45%
0.50 – 2.50 µm	927	796	14%	749	623	17%
2.50 – 5.00 µm	1832	1449	21%	1690	1076	36%
5.00 – 15.0 µm	1895	695	63%	1524	566	63%
15.0 – 30.0 µm	473	11	98%	188	36	81%
30.0 – 75.0 µm	137	0	100%	49	8	84%
> 75.0 µm	1	0	100%	0	0	
Pore	2513	1037	59%	1714	892	48%
Al oxides	1986	1378	31%	1772	907	49%
Cluster Count	275	223	19%	272	149	45%

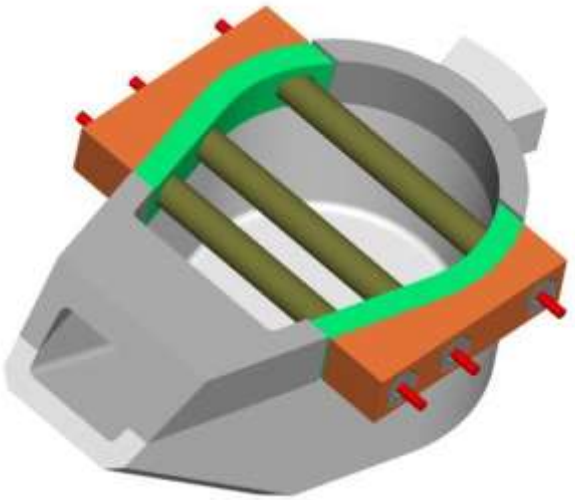
FOSECO

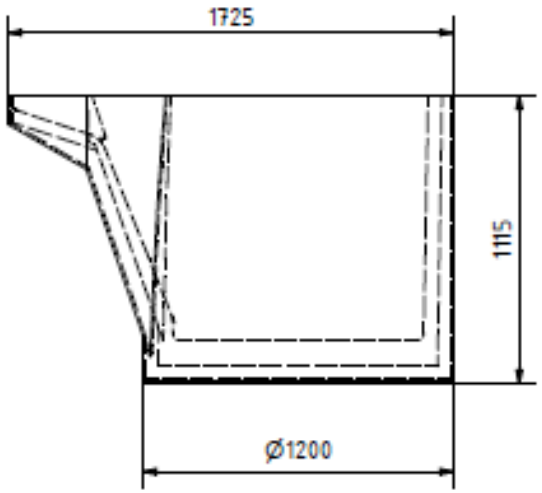
Vmet results – A319TO



ASPEX / V-met analysis – Summary

- Vmet is tool for an evaluation of metal cleanliness of Al foundry alloys
- Vmet evaluates efficiency of metal cleaning by FDU MTS1500 with special fluxes
- INSURAL Transfer Ladle
- INSURAL LINER





FOSECO


FOSECO
THANK YOU
FOSECO