The Strategic University Steel Technology and Innovation Network Presents

Task 3: Scrap Utilisation

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Future Steel Manufacturing Research Hub

UKRI Engineering and Physical Sciences Research Council

The University Of Sheffield.

WMG THE UNIVERSITY OF WARWICK

Names and Organisations

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Introduction to Project

- Significantly increasing the use of UK-generated steel scrap in steel production has become a strategic direction for the UK steel industry.
- This project investigates the influence of residual elements inherited from steel scrap on the processability and properties of typical steel products.
- It focuses on downstream processes of steel manufacturing – casting, re-heating, hot-rolling, cold-rolling, annealing and mechanical properties.
- It will provide fundamental understanding and technology development to maximise the scrap utilisation for the manufacturing of high quality steel products at an economical cost.
- It will help achieve the government compulsory target of reducing CO_2 emissions by 80% before 2050 and net-zero emissions for steel industry, and maintain the sustainability and profitability of the UK steel industry.

Aims and Impact

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Aims

- To reveal the effects of residual elements on steel processability and product qualities for typical steel grades by advanced characterisation and testing;
- To discover the effects of processing parameters on the tolerance of residual elements in steel;
- To explore or implement the knowledge/technologies developed in the project in industry;
- To develop a framework to assess the economically feasible removal limits of the residual elements and the recovery rates of valuable alloying elements from scrap during processing.

Impact

- To provide in-depth understanding and technology development for maximising the utilisation of the UK-generated steel scrap in the production of high quality steel products at an economical cost.
- To ensure the sustainability and profitability of the UK steel industry and minimise the environmental impact.
- To help achieve the government compulsory target of reducing CO_2 emissions by 80% before 2050 and net-zero emissions for steel industry.

Progress to Date

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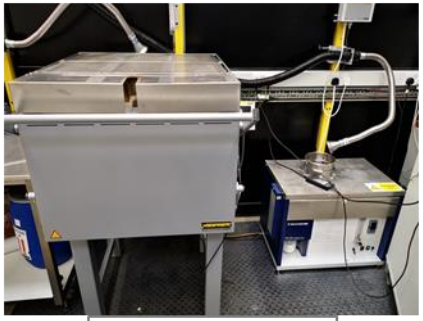
- We have been extensively engaging with industry partners to define the key steel grades to be studied, their processing routes (parameters) and their current specification of residual elements. We are also requesting the industry partners to provide production samples at different stages as benchmarking materials.
- Accordingly, we are designing the experimental layout and chemistry. We are using the melting and casting facilities at WMG of the University of Warwick to make typical steel grades in laboratory, and the start steel grade we are making is Low Carbon Free Cutting Steel (LCFCS) with increased level of residual element copper.
- We are investigating the as-cast microstructure in EBSD. Particles were investigated in SEM-EDS and STEM-EDS. This helps understand the effect of copper associated with MnS particles on copper enrichment along grain boundaries.
- We are carrying out a critical literature review on the effects of residual elements and processing parameters on steel processability and product properties.

Progress to Date

Establishment of laboratory simulated process

Melting+ Casting



Heat Treatment

Rolling

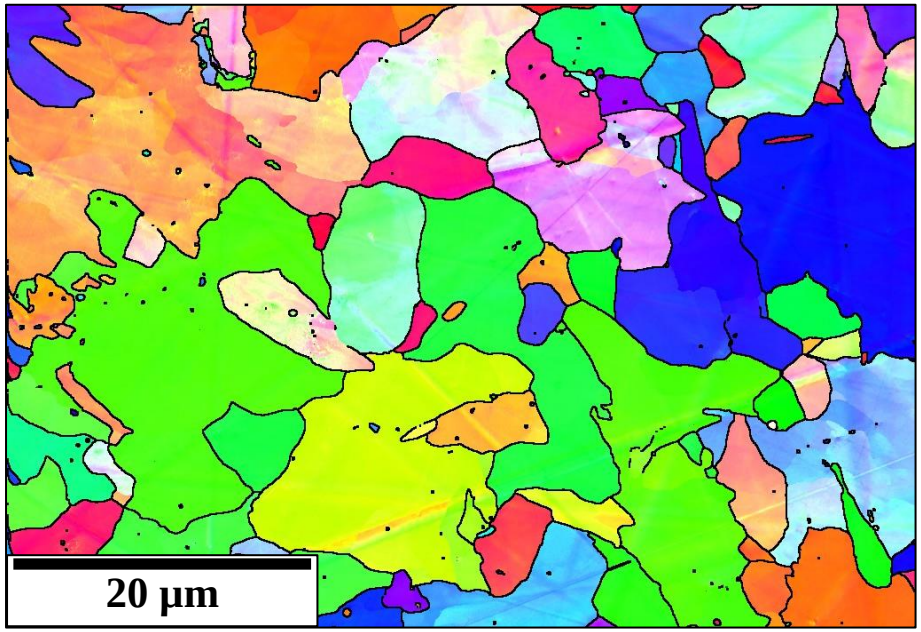
Mechanical Testing

Characterisation

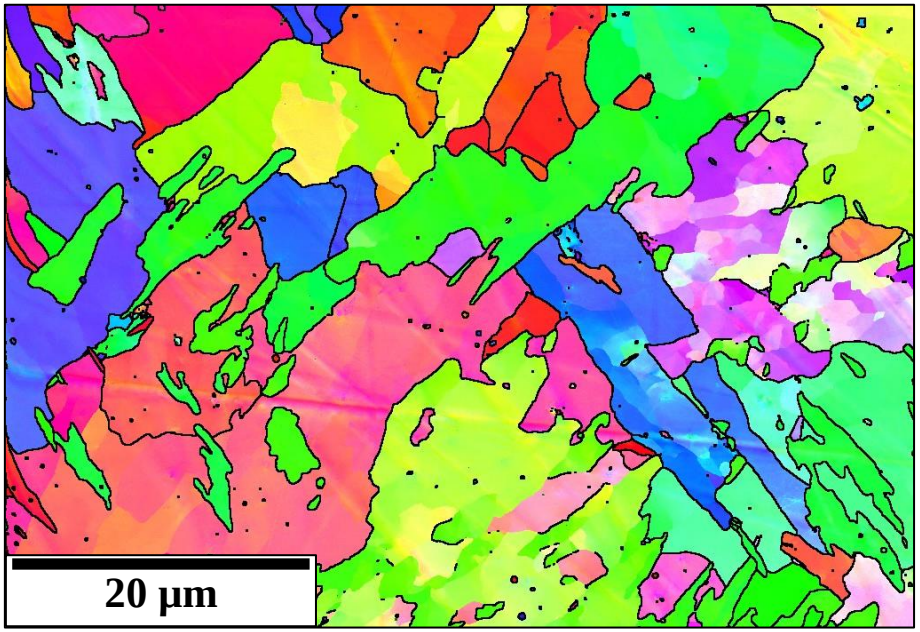
- Impurities influence the processability and quality/service properties of steel products.
- Changing process parameters may increase the tolerance of impurity levels without sacrificing the quality/service properties of steel products.
- Life Cycle Assessment of removal limits of residual elements & recovery rates of alloying elements (University of Sheffield).

Output

EBSD map of as-cast microstructure of Low-carbon free-cutting steel (LCFCS)



Near centre of as-cast

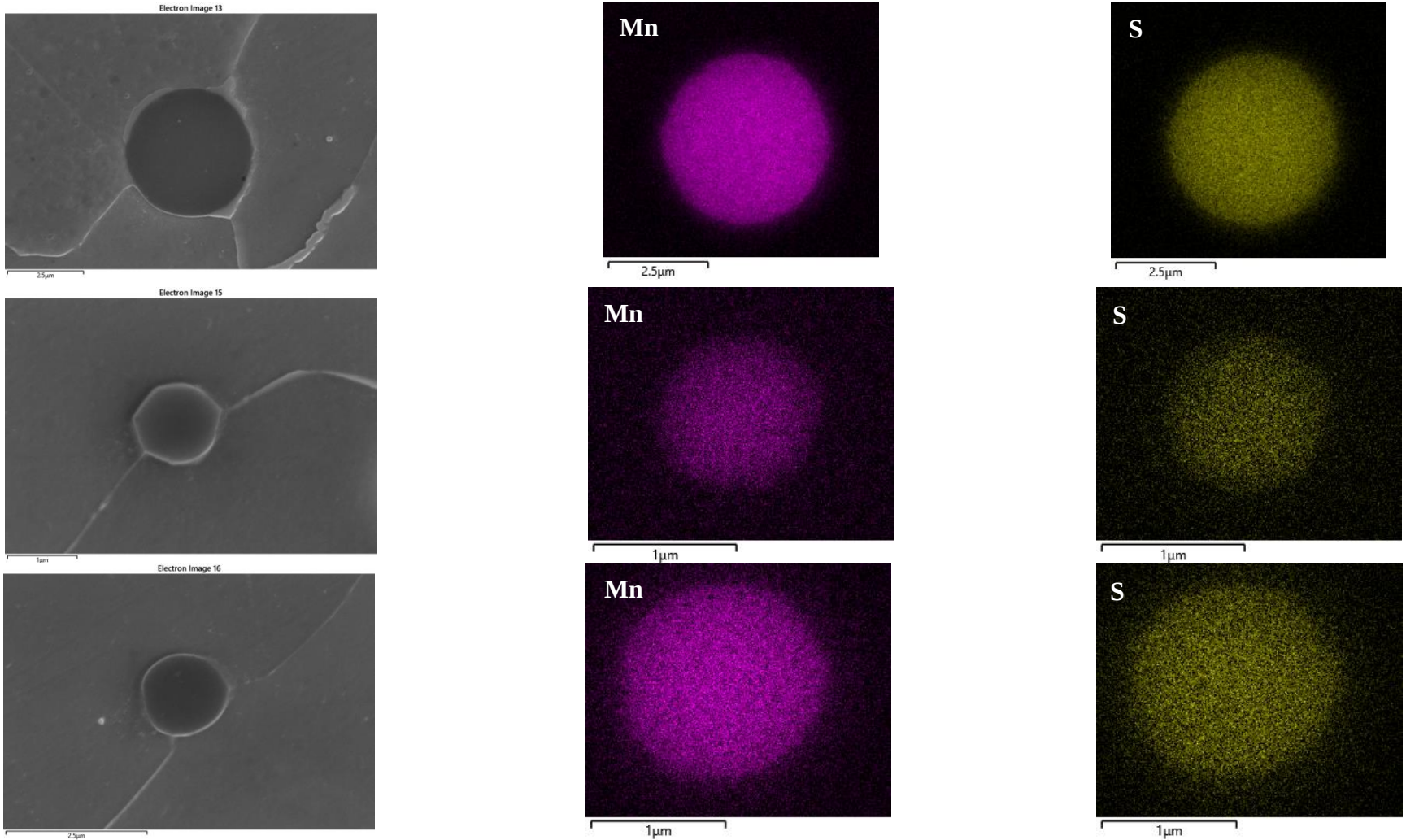


Near chill zone of as-cast

cross-sectional view through casting direction (CD) at the centre of cast

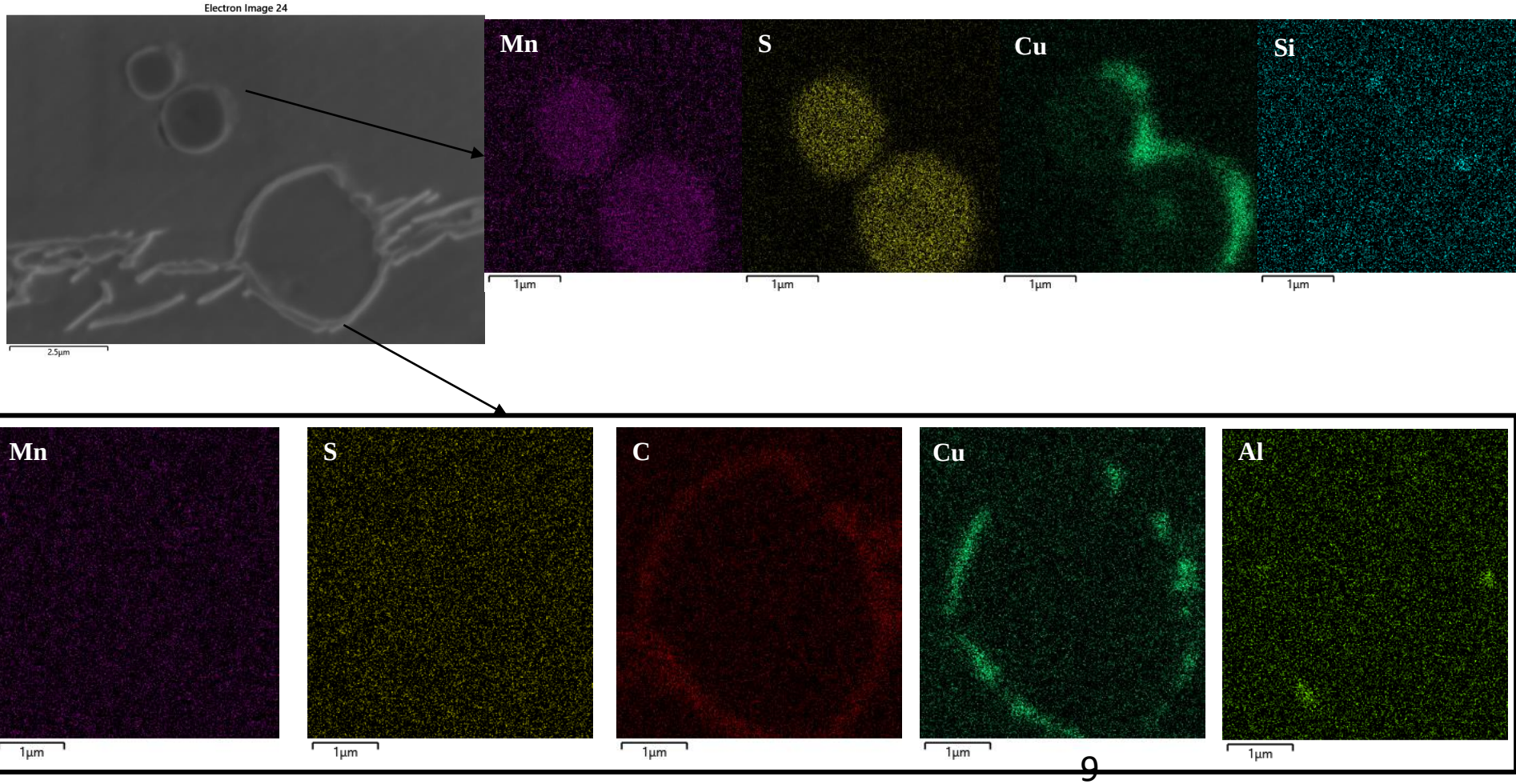
Output

EDS map of (Fe,Mn)S particles in the as-cast microstructure of LCFCS



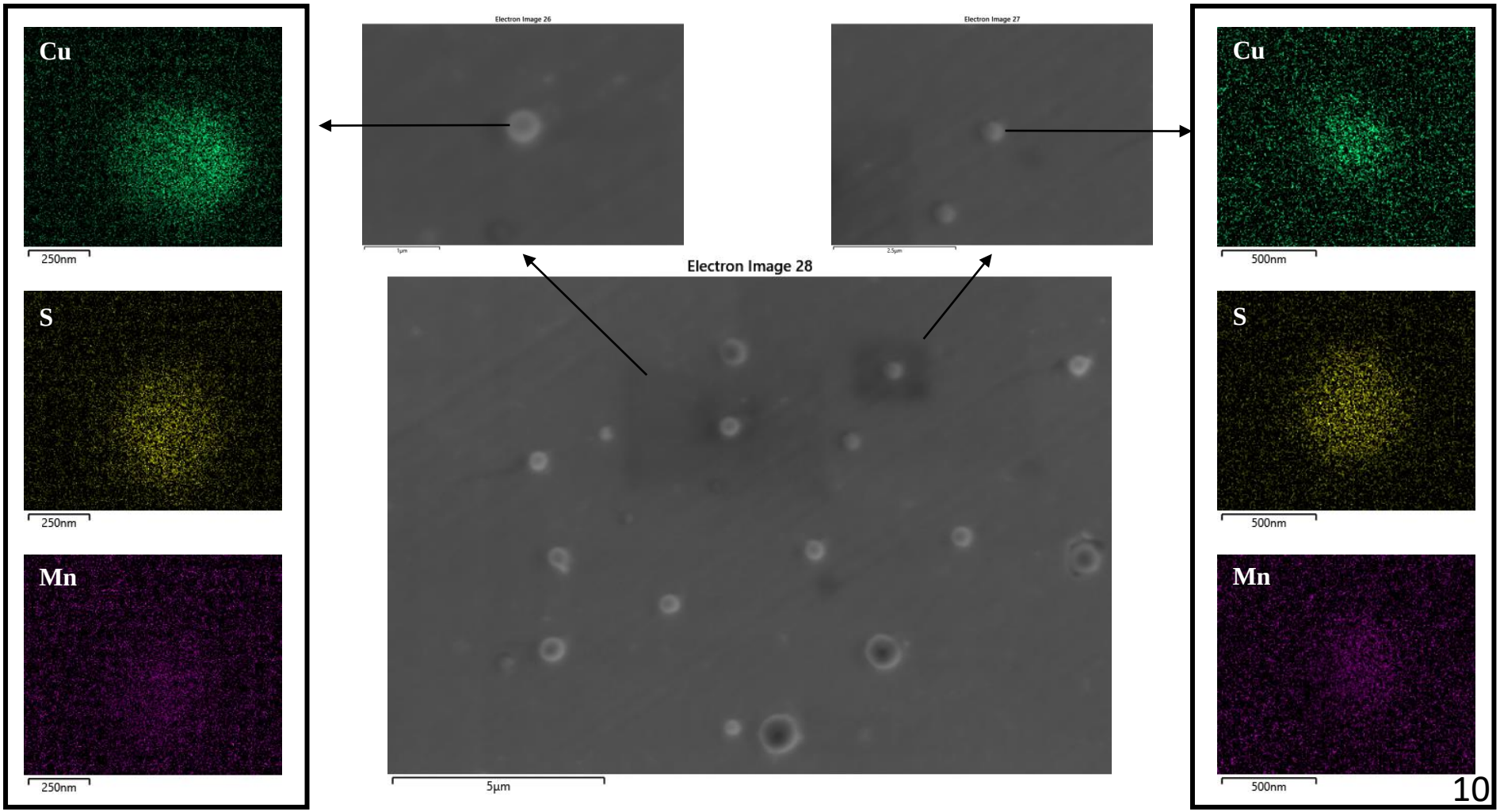
Output

EDS map of copper co-precipitating as a shell around (Fe,Mn)S particles



Output

EDS map of sulphide particles rich in copper



Do Next

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1. To obtain steel samples at different process stages in industry & characterise the samples in laboratory. This has been affected by the unprecedented circumstance due to COVID-19 in both industry and university (off/lab closure).
2. Laboratory benchmarking of the steels produced in industry using the established lab simulation process at WMG. This has also been affected by the lab closure due to COVID-19.
3. To continue the analysis of the experimental results available so far.
4. To continue literature review.
5. To engage with industry partners via virtual meetings on processing conditions.
6. To further define research plan.
7. To recruit PhD student (University of Sheffield).

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