ISIS@MACH ITALIA

Science and Technology Facilities Council
ISIS Neutron and Muon Source

Experiment Proposal

Experiment number GP2024026

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Experiment title	Investigating the Source of Imperfections in Forged Brass Items Using Scanning Electron Microscopy
MRF Instrument	**SEM ZEISS SIGMA**
Access Route	Direct Access
Science Areas	Materials
Sponsored Grant	None
Grant Title	-
Start Date	-
Similar Submission?	-
Industrial Links	RGF SRL

Days requested: 3
Previous GP Number: -
DOI: -
Sponsor: -
Grant Number: -
Finish Date: -

Non-Technical Abstract

Brass, a copper-zinc alloy enhanced with other elements, is widely used in forging to create components for industries like plumbing, automotive, and electrical hardware due to its high thermal conductivity, corrosion resistance, and machinability. However, the forging process can lead to defects such as wrinkles, surface roughness, and inclusions, negatively impacting the mechanical and aesthetic qualities of brass articles. Surface treatments aimed at improving these qualities or corrosion resistance, particularly mechanical polishing for galvanic treatments, also pose challenges by interacting with the brass. Scanning Electron Microscopy (SEM) is essential for analyzing these defects and the effects of surface treatments, providing detailed microstructural imaging and analysis.

Publications -

ISIS neutron and muon source

E-platform: No

Instruments	
Access Route	
Science Areas	
Sponsored Grant	
Grant Title	
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Similar Submission?	
Industrial Links	

Days Requested:
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Sample record sheet

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MRF Instrument **SEM ZEISS SIGMA** **Days Requested:** 3
Special requirements:

SAMPLE

Material	Copper, Zinc	-	-
Formula	Cu, Zn	-	-
Forms	Solid		
Volume	4 cc		
Weight	10 g		
Container or substrate	-	-	-
Storage Requirements	-	-	-

SAMPLE ENVIROMENT

Temperature Range	RT - K	-	-
Pressure Range	atmospheric pressure - mbar	-	-
Magnetic field range	- T	-	-
Standard equipment	-	-	-
Special equipment	-	-	-

SAFETY

Prep lab needed	Yes	-	-
Sample Prep Hazards	No	-	-
Special equip. reqs	-	-	-
Sensitivity to air	No	-	-
Sensitivity to vapour	No	-	-
Experiment Hazards	No	-	-
Equipment Hazards	-	-	-
Biological hazards	-	-	-
Radioactive Hazards	No	-	-
Additional Hazards	-	-	-
Additional Details	-	-	-
Sample will be	Disposed by IS	-	-

Investigating the Source of Imperfections in Forged Brass Items Using Scanning Electron Microscopy

1. Background and Context

Brass, an alloy primarily of copper and zinc with minor additions of other elements to improve its properties, is extensively utilized in the forging process for producing various components across industries such as plumbing, automotive, and electrical hardware. Its notable attributes include high thermal conductivity, good corrosion resistance, and excellent machinability, making it an attractive choice for numerous applications. Despite its advantages, the forging process can introduce defects into brass articles, such as wrinkles, surface roughness, and inclusions, which can detrimentally affect their mechanical properties and aesthetic quality. Moreover, surface treatments designed to enhance surface quality or corrosion resistance, especially those involving mechanical polishing for the subsequent galvanic treatments, present challenges due to their interaction with the brass substrate. Scanning Electron Microscopy (SEM) plays a crucial role in this investigation, offering detailed imaging and analysis of the microstructure to elucidate the nature of these defects and the impact of surface treatments.

2. Proposed experiment

This proposal is part of a dual campaign, integrating findings from Scanning Electron Microscopy with Raman Confocal Microscopy, to understand the microstructural defects in forged brass articles and their interaction with surface treatments, particularly graphite additives used as lubricants in metal forming. Our objectives include: a) identifying and characterizing microstructural defects in forges brass articles; b) investigating the formation mechanisms of these defects during the forging process and subsequent surface treatments; c) assessing the impact of surface treatments on the defects and the overall integrity of the brass articles; d) suggesting improvements in the forging process and surface treatment applications to minimize defect formation and enhance the mechanical and aesthetic qualities of the final products. SEM is instrumental in this experiment for its: a) high-resolution imaging, crucial for identifying defects and understanding their morphology; b) elemental analysis, enabled by energy-dispersive X-ray spectroscopy (EDS), to determine elemental composition, crucial for analysing surface treatments and detecting inclusions; c) non-destructive nature, preserving sample integrity for analysis with multiple techniques. To augment our insight into the microstructural integrity and the defect landscape within forged brass articles, this experiment will also include the analysis of sections from the same samples subjected to surface analysis. This strategy is essential for uncovering internal defects, inclusions, and material inhomogeneities not apparent on the surface. By examining both the external and internal structures of the brass articles, we aim to develop a comprehensive profile of defect types, distributions, and their potential origins within the material. This dual analysis approach will significantly aid in identifying the root causes of defect formation and proposing more effective strategies for improving the forging process and the application of surface treatments. Including cross-sectional analysis ensures an exhaustive examination of the brass articles, offering a fuller understanding of the challenges and opportunities for enhancing material performance and product quality.

3. Summary of previous experimental proposals or characterisation

The link between the forged brass process, surface treatments, and defect formation has traditionally relied on a trial and error approach, supplemented by empirical knowledge. This method, while

offering some insights, lacks the precision and predictability afforded by scientific analysis. Small and medium-sized enterprises (SMEs) in the forging sector, in particular, encounter obstacles due to limited access to advanced analytical methods like SEM and the necessary expertise to interpret data effectively. Although scientific literature provides a foundation on forging, microstructural analysis, and the effects of surface treatments,[1-3] detailed knowledge about their interplay, especially concerning graphite-based treatments, is scarce. This proposal seeks to fill that knowledge gap through focused research.

4. Justification of experimental time requested

As detailed in section 2, scanning electron microscopy is a crucial tool for this experiment due to its unique capabilities. We request 3 days of experimental time to analyse 24 samples: 12 samples where the surface will be thoroughly investigated (flat samples will be used to help in the analysis) and 12 samples obtained by sectioning the forged articles. This number ensures diverse representation from different batches or treatment conditions. The first day will be dedicated to the imaging and EDS mapping of all 12 surface samples. The second day will focus on high resolution imaging and mapping on regions of interest selected from on a preliminary review of the collected data to identify key patterns, anomalies, and areas requiring deeper investigation. This step is crucial for effective time management and prioritizing detailed analyses. The final day is reserved for the analysis of sections, based also on the compilation of initial findings. This structured approach allows for thorough examination while maintaining a strict timeline.

[1] Kunčická, Lenka, and Radim Kocich. "Effects of Temperature (In) homogeneity during Hot Stamping on Deformation Behavior, Structure, and Properties of Brass Valves." Advanced Engineering Materials 24.7 (2022): 2101414.
[2] Pantazopoulos, G. "A review of defects and failures in brass rods and related components." Practical Failure Analysis 3.4 (2003): 14-22.
[3] Liu, Wei, et al. "Component Analysis of Defects in Secondary Special Brass Alloy." TMS 2020 149th Annual Meeting & Exhibition Supplemental Proceedings. Springer International Publishing, 2020.