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Exploration of Potential Treatments of Bronze Disease Through SEM/EDX Analysis

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Introduction

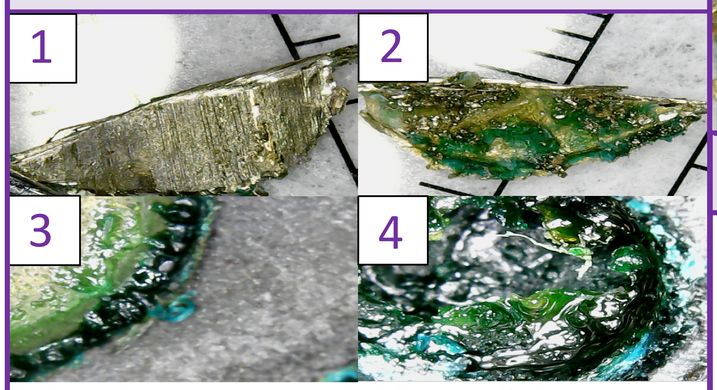
Bronze Disease

- Corrosion of bronze artifacts
- Disease begins with chloride containing compounds.[1]
- Unsure what exactly the chemical composition of the disease is.[2,3,5]

Artifact Remediation

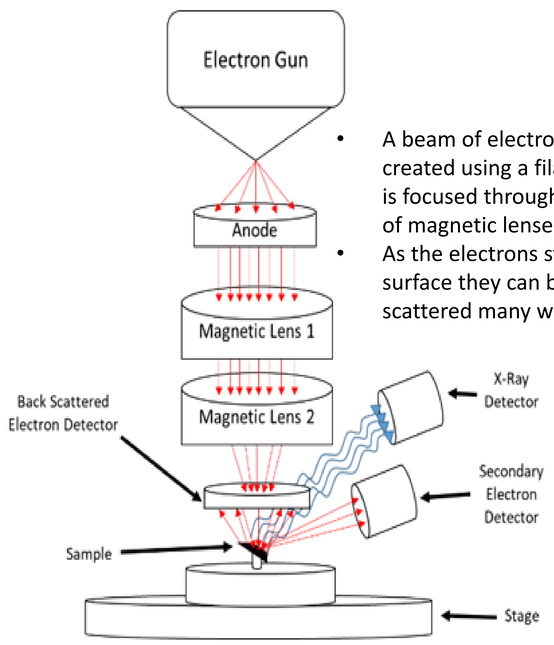
- Need cleaning method to preserve these artifacts
- Previous methods were tested using visual cues
- sodium sesquicarbonate was used to neutralize the chlorinated compounds.[2,3,4]

Bronze Disease



1)Clean Shaving **2) "Diseased" Shaving**
3) Leather/Bronze Interface **4) "Diseased" Rivet**
Microscope images depicting the residual damage of Bronze Disease. The images depict two different diseased rivets on the belt including one that was so damaged that it fell off.

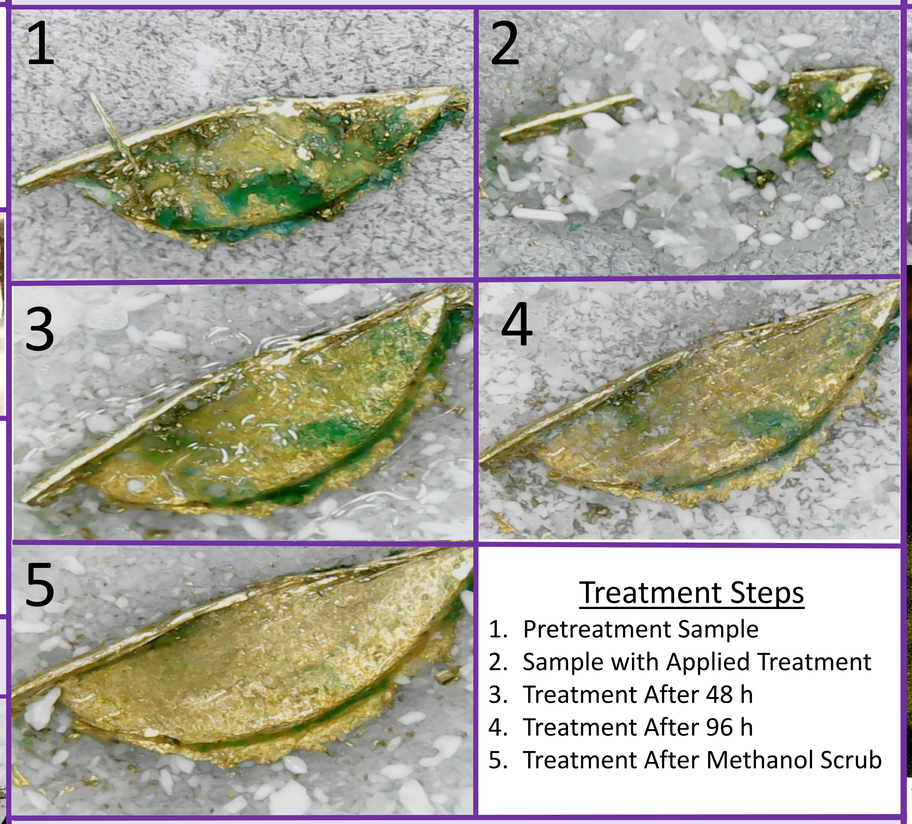
SEM/EDX Methodology



- A beam of electrons is created using a filament and is focused through the use of magnetic lenses
- As the electrons strike the surface they can be scattered many ways

Scanning Electron Microscope and Energy Dispersive X-Ray Analyzer Diagram

Sodium Sesquicarbonate Treatment

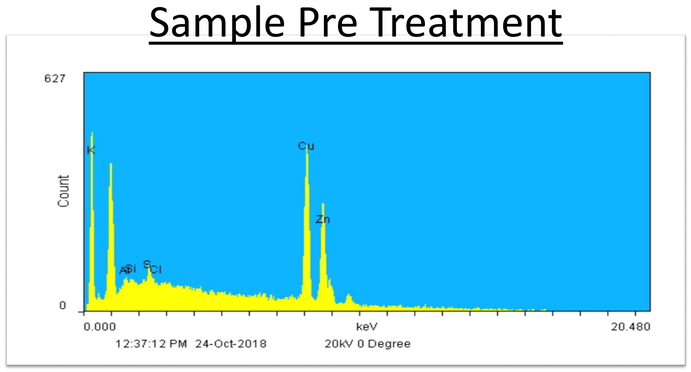


Treatment Steps

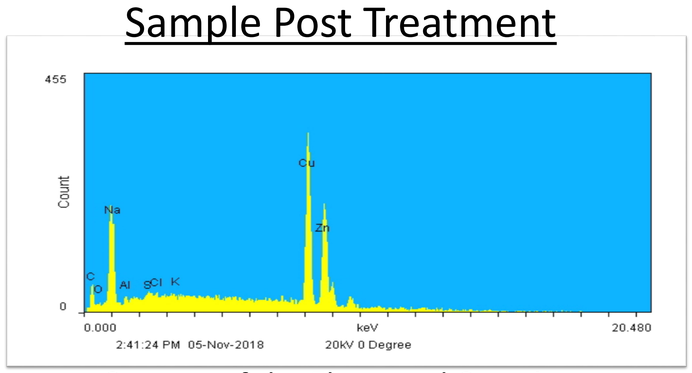
1. Pretreatment Sample
2. Sample with Applied Treatment
3. Treatment After 48 h
4. Treatment After 96 h
5. Treatment After Methanol Scrub

Post-Treatment EDX

Sample Pre Treatment



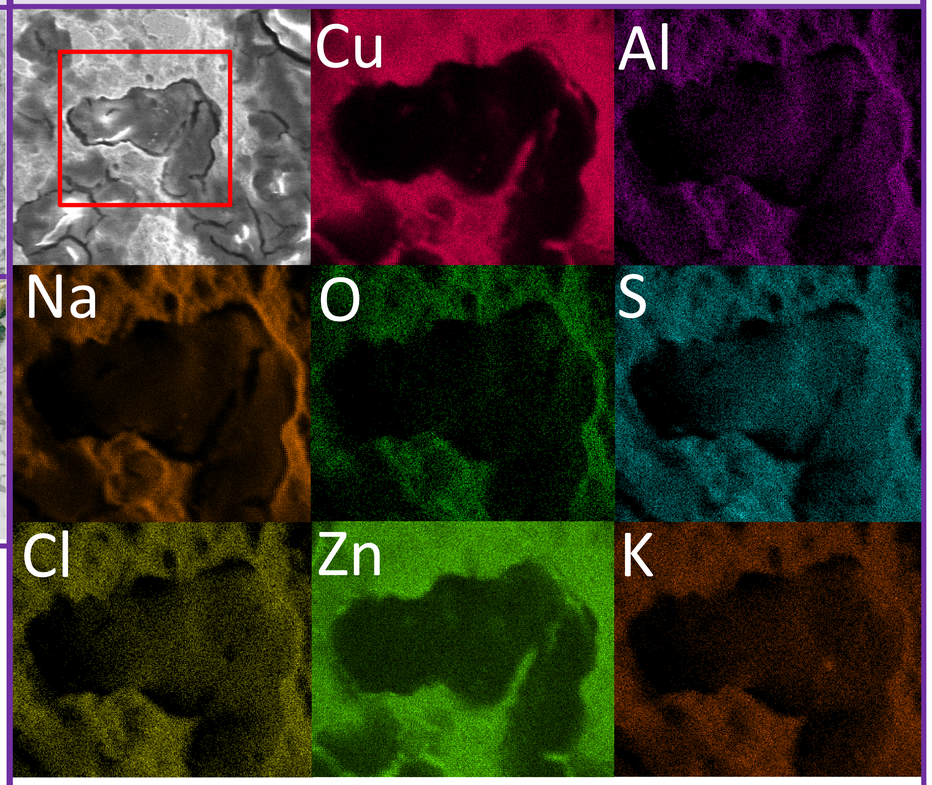
Sample Post Treatment



Sources of the Elemental Constituents

- **Copper (Cu)** – Part of the Bronze Alloy[6]
- **Aluminum (Al), Silicon (Si), and Zinc (Zn)** – Part of the Bronze Alloy[6]
- **Potassium** – Possibly From of the Salts used in the tanning of the leather (KCl)[7]
- **Chlorine** – Makes up the bulk of the diseased portions Cl^- possibly originated from the use of salts in the tanning process (KCl)[7]
- **Sulfur** – Could also be a remnant from the leather tanning process[8]

Post-Treatment EDX Mapping



The above EDX maps are of a portion of the cleaned bronze from step 5 of the treatment described previously. The original SEM images shows some microcracking left from the progression of the bronze disease. There is still chlorine present on the sample particularly on the "dragon's head" portion of the image. This shows that a naked eye analysis of the effectiveness of a treatment doesn't necessarily mean that the bronze disease has been fully removed.

Conclusions

The sodium sesquicarbonate was shown to remove the diseased patina and chlorides from the sample this removal uncovered micro fractures left from the bronze disease. This treatment is both cost effective and safe for curation staff. Further testing of this treatment on other materials, such as leather, that the artifact might be made of would be required before applying them to the museum artifacts.

Acknowledgements

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References

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