

Scientific analyses applied to the study of early modern medals

Francesca Di Turo

Introduction

The project MeB (*Conoscere e conservare i piccoli metalli del Bargello: nuove indagini storico-artistiche e scientifiche su medaglie e placchette d'età moderna*)¹ started in 2020 and lasted two years, facilitated the close collaboration between applied sciences and the humanistic field. Moreover, the synergy with the scientific laboratories of the Scuola Normale Superiore, the National Enterprise for NanoScience and NanoTechnology (NEST), made it possible to apply non-invasive and non-destructive techniques to three medals that had never been studied before.²

The aim of the present essay is to emphasize the scientific contribution and the opportunities offered by diagnostics when applied to the study of medals, to get scholars acquainted with the existence of new frontiers of knowledge, advocating for the recognition of multi- and inter-disciplinarity as an added value to the field of art history. Scientific data play a pivotal role in various aspects of humanistic research, significantly contributing to the preservation and understanding of our cultural heritage. Firstly, in the realm of preservation, scientific analysis unveils the composition and structure of artifacts, empowering conservators to employ tailored conservation techniques, ensuring the endurance of artworks for future generations. Secondly, scientific analysis provides historical insights by offering valuable information about the technology and materials used by ancient civilizations. This aspect supports art historians in comprehending socio-economic, cultural, and technological aspects of ancient societies. Additionally, the analysis can help in determining artifact ages and verifying their authenticity, crucial for constructing reliable historical timelines. Cultural exchange and trade routes are illuminated through the analysis of artifact composition, unveiling trade patterns and exchanges between civilizations. Lastly, scientific analysis could favour the identification of production purposes, shedding light on whether artifacts served daily activities, religious rituals, or specific functions, enriching our understanding of ancient cultures

and belief systems. In essence, scientific data are often indispensable for preserving cultural heritage, gaining historical insights, accurately dating, understanding cultural exchanges, and identifying production purposes, thereby contributing to the multifaceted landscape of humanistic research.

While one might initially believe that analyses could pose a risk to the integrity of works of art, modern technology provides a diverse range of options for selecting the most suitable analytical techniques, specifically conceived for individual case studies. In the field of conservation science, non-invasive and non-destructive methodologies are consistently preferred, and only when these are proven insufficient to address the inquiries posed by the history of art, one could consider to 'sacrifice' portions of the analyzed sample (typically in the order of micrograms, depending on the employed technique).

Interpretation of data obtained from non-invasive techniques is a nuanced process that demands specialized expertise and frequently necessitates a combination of methods for thorough analysis. The complexity of interpreting such data underscores the importance of skilled professionals in the field. However, challenges emerge concerning accessibility due to the cost of the equipment. Acquiring and maintaining the non-invasive equipment can be financially burdensome, posing a limitation on access for certain cultural institutions and researchers. Additionally, the efficacy of these techniques may face hurdles when confronted with surface limitations, particularly in the examination of objects with intricate surfaces or multiple layers. These constraints highlight the need for a balanced approach in the application of non-invasive methods, considering both the interpretative expertise required and the practical challenges associated with equipment accessibility and surface complexities.

Using this approach, the challenge of the analysis on Alessandro Cesati's medals was addressed, and the following paragraphs will explain the analytical



Fig 1. Medal 6262, obverse and reverse and its characteristic conformation, which consists of two thin foils pasted to a central body
Alessandro Cesati
Complex alloy (Sn, Pb, Au, Ag), 51.7 mm
Florence, Museo Nazionale del Bargello, inv. 6262
Photo: Giulia Daniele

techniques and how they were used to unveil new aspects about the objects and the technology employed by the artist in the production of these medals.

The medals

Cesati's medals were a truly unique case study due to their nature as thin uniface metal strikings, setting them apart from what might be considered 'normal' medals. In one case, two foils are pasted to a central core to replicate the appearance of a genuine medal (fig. 1), while the other two specimens present themselves as exceptionally thin leaf metals, featuring exogenous material on the back side devoid of artistic details. This use of thin strikings is distinctive to Alessandro Cesati (c. 1505 – before 1574), a renowned yet understudied goldsmith, gem-cutter, and medallist.³ Nicknamed *Il Greco* or *Grechetto* ('The Greek'), Cesati, born in Cyprus, rose to prominence during the pontificate of Paul III Farnese (1534–1549) when he became the Master of the Roman Mint. It is likely that he employed these pieces as samples sent to possible patrons outside Rome, to show his extraordinary artistic skills. The medals analysed within MeB were crafted by Cesati for Pope Paul III and Pope Julius III (1550–1555), and since they had never been analysed before, we lacked precise data on their composition. The considered samples are inventoried in the Bargello Museum as: 6262, 6269, and 6275.

The objectives of the scientific analysis

The research objectives are meticulously tailored to fill the existing gap in our understanding of the composition and production technology of Alessandro Cesati's medals. The lack of precise data on the composition of these exemplars, which had never undergone previous analysis and were assumed to be made of silver, prompted our initial investigation into the nature of the metal used. Employing non-invasive and non-destructive analysis techniques, we aim to shed light on the artist's distinctive use of thin uniface pieces and Cesati's unique production technique. The elemental composition and surface morphology are scrutinized using a Scanning Electron

Microscope with an Energy Dispersive System (SEM-EDS). To comprehensively examine the samples, Fourier-Transform Infrared Spectroscopy (FTIR) is employed to characterize the organic material present on the back side of the medals. This multi-faceted approach seeks to unravel the mysteries surrounding Cesati's artistic choices and unveil the technological intricacies behind the creation of these remarkable artifacts.

The scientific analysis

The pivotal tool employed to extract substantial information on the selected medals was SEM-EDS. This technique amalgamates data coming from secondary electrons (SE) for surface imaging, backscattered electrons (BSE) for compositional contrast, and X-ray signals (EDS) for detailed elemental analysis. The integration of such data provided a comprehensive understanding of the morphology, composition, and structure of a diverse array of materials. Upon examining these signals on medals, deposits of dust and organic materials were revealed on the surfaces, visibly accumulated in tiny craters. Nevertheless, the surface maintained a smooth and well-preserved condition, devoid of corrosion issues, with artistic details clearly visible and well-defined, albeit with some scratches likely resulting from previous cleaning procedures. The smoothness implies that the medals were presumably produced through striking technique, as evidenced by the absence of air bubbles and surface roughness, two features typical of cast medals (fig. 2).

EDS played a crucial role in both qualitative and quantitative elemental analysis. Its utility lies in identifying the elements composing a sample, determining their concentrations, and generating elemental maps that illustrate the distribution of specific elements. In the context of our superficial analysis, the data indicated that the primary metals used in the visible sides of the medals were gold, silver, copper, and lead. Although the presence of gold, silver, and copper might initially lead to the assumption that the medals were made from this alloy, two important clues prompt us to reconsider this assumption:

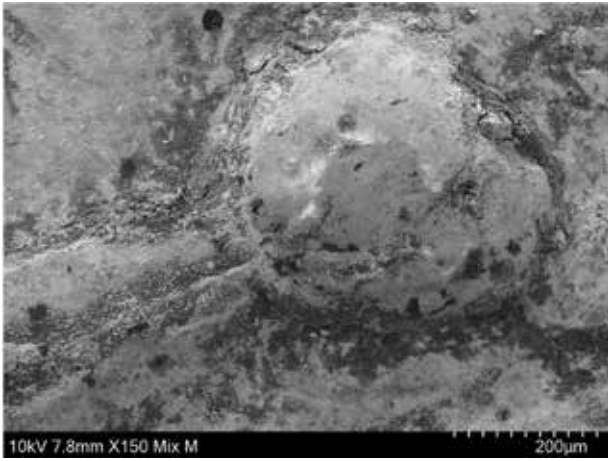


Fig 2. Detail of 6269, showing the SEM image that highlights the dirt deposits around the decoration while revealing a generally smooth surface devoid of air bubbles

Alessandro Cesati
Complex alloy (Sn, Pb, Au, Ag), 46.7 mm (obverse), 46.9 mm (reverse)
Florence, Museo Nazionale del Bargello, inv. 6269
Photo: Francesca Di Turo

firstly, the gold-copper alloy is uncommon, suggesting that this was not the original alloy used by Cesati; furthermore, the additional presence of lead, detected by EDS, implied that we explored alternative possibilities for the production of such pieces, considering the superficial plating of inexpensive alloy thin foils with gold or silver, to mimic the effect of more precious metals. In fact, the inclusion of lead in the elemental composition introduces complexity to the alloy makeup, urging us to consider a broader range of material combinations employed by the artist.

The resolution to this question unfolds through the examination of medal 6275: a composition of two separate thin sheets likely adhered to a lost support. In this case, the analysis of the unworked back part provided insight into the true nature of the metal alloy employed by Cesati, revealing a microstructure with distinctive characteristics (fig. 3). The foil showed a structure in which the partitioning of tin and lead resulted from the

low solubility of lead into tin. This typical microstructure emerges because of the substantial non-solubility of lead in tin during the solid state, forming a dispersion of islands within a tin matrix. The number and distribution of these lead islands are influenced by various factors, such as lead content, casting temperature, and cooling rate. Moreover, the seemingly random distribution of lead islands suggests no preferential trend related to the mechanical processing of the foil and the dimensions of the lead aggregates supported the notion of a slow cooling rate, indicating gradual solidification and allowing the clustering of lead over time.

The extensive incorporation of lead served a dual purpose in Cesati's artistic process, facilitating the manipulation of a metallic liquid alloy and enhancing the striking of the final product. Cesati was aware of how variations in elemental composition impacted mechanical properties of the metals; the addition of lead in higher percentages notably improves machinability, easing the production process. The complexities of the alloy composition and the presence of silver underscore the intricacies of Cesati's craftsmanship, and the complex processes involved in the creation of these unique artifacts.

The analysis of organic residues on sample 6269 using Fourier Transform Infrared Spectroscopy (FTIR) indicates that Cesati employed resin to bond these foils. As mentioned in the introduction, FTIR is used for the study of the compositional analysis of organic materials, offering a characteristic spectrum that can be compared with literature data.

After scrutinizing the acquired data and comparing it with existing literature results, it is reasonable to infer that the organic material discovered on the metal surface is likely a vegetal resin, particularly mastic, a glue commonly used by many artists in the past. However, the identification of resins is a challenging task due to the multitude of types, to their intricate composition, and to the variations

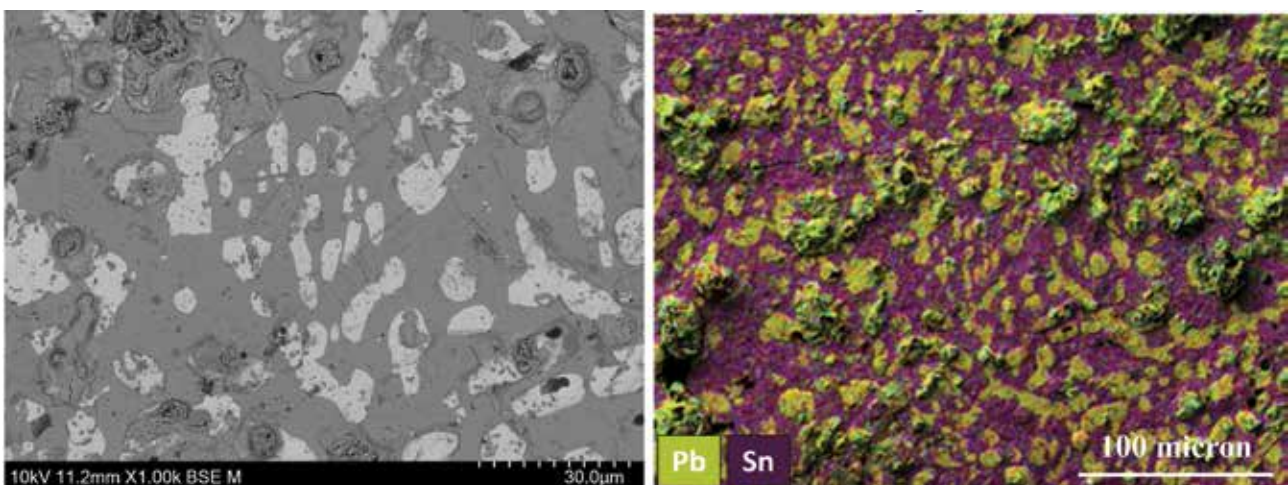


Fig 3. The microstructure of the metal reveals lead islands within a tin matrix, providing evidence that Cesati utilized this alloy to craft the thin sheets, later plated with layers of gold and silver

Alessandro Cesati
Complex alloy (Sn, Pb, Au, Ag), 47.1 mm
Florence, Museo Nazionale del Bargello, inv. 6275
Photo: Francesca Di Turo

they undergo over time due to processes like oxidation or polymerization. The complexity of resins underscores the difficulties in achieving a precise identification despite the rich data provided by FTIR analysis.

Conclusions

Scientific data enabled us to reconstruct the production process of the medals as follows: Cesati obtained a thin sheet primarily composed of lead and tin. Subsequently, he used striking to impress on the foils the desired figures and then covered this sheet with layers of silver and gold, creating the illusion of a precious metal. Finally, he affixed these adorned metal sheets onto a central support using resin glue, resulting in the final appearance of the medal. This study employed SEM-EDS to investigate the elemental composition and surface morphology of specimens from the Bargello Museum. Based on the discussed results, we concluded that Cesati crafted the foils using an inexpensive alloy of tin and lead plated with silver and gold. Mechanical working with a soft hammering technique was moreover confirmed by the absence of a preferential orientation of lead islands during SEM analysis. The dimensions of the lead aggregates suggest a slow cooling rate, allowing the gradual separation of lead from tin.

FTIR analysis played a crucial role in identifying resinous material on sample 6269, a feature also observed on sample 6262. This research, conducted on unique artistic pieces from a public museum, unveils the composition of the considered exemplars for the first time. The scientific data obtained are an important contribution to historical research, answering interesting questions about Cesati and his production techniques. The acquired data therefore enriches our understanding of Renaissance medals and opens the way to further insights.

The scientific analysis conducted on Cesati's artworks not only deepened our understanding of the production technology employed by the artist, but also shed light on his creativity and significant contributions to the arts. By successfully applying scientific analysis to objects preserved in a museum context, we have moved beyond mere preservation, delving into the unknown facets of our artistic heritage, and ensuring their transmission to future generations.

The integration of scientific analysis in museums transcends being a mere choice; it symbolizes a profound commitment to unravelling the hidden aspects of our artistic legacy. It is a bridge between science and humanities, forging a powerful connection that yields results capable of opening new paths of study and research. Embracing this synergy therefore offered a holistic approach, enriching our understanding of Cesati's work and providing fresh insights that contribute to the broader tapestry of human knowledge.

NOTES

1. The project received co-financing from the European Union, the Italian Republic, Regione Toscana, and the Scuola Normale Superiore. The fellowships were generously funded by POR FSE TOSCANA 2014–2020 as part of the 'GiovaniSi' project (www.giovanisi.it), an initiative promoted by Regione Toscana aimed at empowering young people and scholars. I would like to extend my gratitude to Prof. Lucia Simonato, Dr. Giulia Daniele, Dr. Giandonato Tartarelli, the Director of the Museo Nazionale del Bargello, Dr. Paola D'Agostino, Dr. Aldo Moscardini, and the NEST laboratories for their invaluable contributions. Special thanks to Prof. Fabio Beltram and Dr. Pasqualantonio Pingue for their guidance in conducting the scientific analysis.

2. For the scientific results see Di Turo, F., *et al.*: Disclosing the composition of the Renaissance thin uniface metallic striking by Alessandro Cesati (mid-16th century) from the Bargello Museum using non-invasive analyses, *Journal of Cultural Heritage*, no. 63, 2023, pp. 422-429.

3. See on the artist Daniele, G.: A 1550 'double Jubilee' medal by Alessandro Cesati, *The Burlington Magazine*, vol. 165, no. 1448, November 2023, pp. 1190-1195, and Giulia Daniele's essay in this volume, with previous bibliography.