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Paintings on metal supports: new details and broader Central European perspective

Pinturas sobre suportes metálicos: novos detalhes e uma perspetiva mais ampla da Europa Central

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Abstract

This article presents the current research results on paintings created on metal supports. The research that was conducted highlights the diversity of this group of objects. Unlike collections in Western Europe, where most paintings are made on copper plates, paintings on supports such as tin-lead alloys, silver, steel, and zinc are not uncommon in Poland. Additionally, these supports may be covered with other layers, such as silvering, gilding, or tinning. This article seeks to expand and organise knowledge on various types of metal supports by comparing literature data with available artefacts. Despite introducing new materials in modern artworks, metal remains an important medium, offering valuable insights into the evolution of artistic techniques and the relationship between materials and their aesthetic, symbolic, and practical functions in the visual arts. This may assist future researchers in accurately identifying the historic object and developing an appropriate conservation programme.

KEYWORDS
Paintings on metal
Copper
Silver
Tin
Steel
Zinc

Resumo

Este artigo apresenta os resultados da investigação em curso sobre pinturas realizadas em suportes metálicos, evidenciando a diversidade deste grupo de objetos. Ao contrário das coleções da Europa Ocidental, onde a maioria das pinturas é feita sobre placas de cobre, na Polónia não são raras as pinturas sobre suportes como ligas de estanho-chumbo, prata, aço e zinco. Para além disso, estes suportes podem ser prateados, dourados ou estanhados. Este artigo procura expandir e organizar o conhecimento sobre os vários tipos de suportes metálicos, comparando os dados da literatura com os artefactos disponíveis. Apesar da introdução de novos materiais em obras de arte modernas, o metal continua a ser um suporte importante, oferecendo conhecimentos valiosos sobre a evolução das técnicas artísticas e a relação entre os materiais e as suas funções estéticas, simbólicas e práticas nas artes visuais. Isto poderá ajudar investigadores a identificar com precisão e conservar o objeto histórico.

PALAVRAS-CHAVE
Pinturas sobre metal
Cobre
Prata
Estanho
Aço
Zinco

Introduction

Paintings on metal, considerably rarer than those on canvas or wooden supports, have historically received less attention from researchers than other easel paintings. However, among paintings created on metal, it is a fact that the most attention has been paid to paintings on copper supports.

Many scholars have attempted to answer the question of how artists came to use metal supports for their works. Among them, Isabel Horovitz provides comprehensive information in her articles and publications on the history of research into the use of metal supports and the methods of their conservation [1-2]. Two multi-author publications, *Copper as canvas* (1999) [3] and *Paintings on copper and other metal plates* (2017) [4], are also invaluable sources of knowledge on this subject. However, as the titles of these publications suggest, the topics addressed primarily concern paintings created on copper.

In 2012, an outstanding publication titled *Conservation of easel paintings* was released as part of the *Routledge series in conservation and museology* [5]. However, even in such an extensive work spanning over 900 pages, only about 10 are dedicated to paintings on metal supports. It should be noted, however, that a significant advantage of this publication is its attention to the variety of metals used as painting supports. It divides the supports into the following chapters: copper, copper coated with tin and other metals, copper covered in gold leaf, silver, tin and tin-plated iron, zinc, aluminium, magnesium, steel and stainless steel supports. For this reason, and due to the relatively recent publication date, this publication will directly refer to this work, supplementing technological and material information and proposing a different division of metal supports.

This article presents a structured overview of selected metal supports used in easel painting, with particular attention given to sources and case studies from Polish experience. Due to the limited availability of comprehensive literature on this topic – and the additional barrier posed by language – significant regional contributions have often remained outside the scope of broader international discourse. To avoid further simplification of an already fragmentary body of knowledge, selected excerpts from key texts are quoted directly. This approach ensures fidelity to the original content, especially where technical or terminological precision is essential. The aim is not only to supplement the current understanding of paintings on metal supports, but also to reposition Central European examples within a more global framework. When restorers encounter artworks on atypical supports, such as zinc, they are frequently left without appropriate comparative material or typological references. The prevailing assumption that "metal support" equates to "copper" remains universally unchallenged [6]. This oversimplification, exacerbated by frequent citation of a narrow pool of sources, contributes to the perpetuation of inaccuracies and a lack of contextual clarity.

This publication therefore proposes a clarified and expanded typology of metal supports, drawing on specific object-based examples and recent bibliographic developments. Its goal is to establish a technical and historical foundation for further comparative research and to stimulate deeper inquiry into the material diversity of paintings on metal in worldwide collections.

Historical context

Imitation of gold objects – varnishes and coatings in the Near East

To trace the genealogy of paintings created on metal supports, we must look back many centuries and expand the scope of our terminology from metal-support paintings to polychromy on metal. The earliest written sources regarding the application of varnishes or coatings to metal surfaces date from the late third century CE to the Leyden Papyrus X [7] and the Stockholm Papyrus [8]. The methods of metal colouring described in these texts refer to

solutions containing sulphides of alkali metals as well as mineral and plant-based compounds, which allowed for the creation of coloured coatings, giving metal objects a more refined appearance and making them resemble gold or electrum [9]. At this stage, the metal surface modification was based on either a durable surface chemical reaction or the application of a coloured coating. However, the manuscripts do not mention the use of an additional binding medium, suggesting that the inherent viscosity of the mixtures containing plant extracts played a crucial role. On this basis, such coatings were not particularly permanent, as they relied primarily on water-soluble carbohydrates present in the plant-based substances. The colouring effect aimed to replicate the appearance of gold alloys, focusing on achieving a warm hue. As this practice occurred in the ancient Near East, only objects made using the materials available at the time could undergo such treatments, including silver, iron, tin, and lead alloys. Copper and bronze, due to their inherent colour, would likely have been gilded using a gold-mercury amalgam or gold leaves on gesso if they were to be used for imitating gold objects [10]. Many centuries later, Benvenuto Cellini (1500-1571) still described methods for applying amalgam gilding and various techniques for its colouration for purely decorative purposes [11, chapters 27-32].

Decoration of metallic foils – glazes

Further technological and practical notes, manuscripts, and treatises from the medieval period bring us closer to the topic of decorative polychromy on metal. In the eight-century *Lucca Manuscript*, there is a description of tin leaves used in paintings on wooden panels, which were coated with an oil varnish tinted with a mixture of saffron and orpiment to imitate the appearance of gold [12]. Of course, gold leaves were also widely used in panel painting, especially as a background for sacred scenes, as they had symbolic significance. In the twelfth century, Theophilus Presbyter, in his work *Diversarum Artium Schedula* also mentions the possibility of covering tin leaves with pigments mixed with linseed oil, thereby creating a transparent glaze, known as an "aureole" [translucent painting], or an appropriate colour mixture for depicting faces and robes [13, Book 1, chapters 24 and 27]. This is the earliest known description of using pigment and linseed oil as a binder for creating an opaque painting on a metallic surface. In subsequent chapters, Theophilus Presbyter discusses using tin powder when gold and silver are unavailable for illuminations. He recommends, as in the *Lucca Manuscript*, the use of saffron to imitate gold, but with a binder of egg white [13, Book 1, chapter 30]. In the fifteenth century, Cennino Cennini, in his work *Il libro dell'arte*, describes the use of metallic foils in wall paintings, specifically gold, silver, and gilded tin leaf, in combination with full-colour modelling to create the effect of luxurious robes (chapters 99 and 143). Cennini advises applying these foils to an oil-resin mordant, which, like on walls, is also effective on paintings, glass, and iron (chapter 151). He also provides a recipe for a mordant made from garlic juice, which is not recommended for moist, porous surfaces like walls but is suitable for use on paintings and iron (chapter 153) [14]. Examples of artworks in which metallic foils were used in wall painting include Giotto's frescoes in the Scrovegni Chapel in Padua, dated 1303-1306, as well as Simone Martini's *Maestà* (Madonna Surrounded by Angels and Saints), a fresco painted in 1315 in the Palazzo Pubblico in Siena [15]. In the seventeenth century, Théodore Turquet de Mayerne, in his treatise (1620-1646), describes his experiments with transparent coatings on metallic foils and, with admiration, notes that the technique of coloured glazes on silver leaves was employed by Hans Holbein the Younger in the sixteenth century to faithfully render naturally glossy objects such as gold, silk, and satin [12, 16].

Other contexts

The development of oil painting techniques in the fifteenth century undoubtedly played a significant role in the widespread adoption of metal supports as materials suitable for artistic purposes. Van der Graaf traces the origins of oil glazing techniques to the fourteenth-century monumental glass painting [12]. Cennino Cennini describes the preparation and application of

oil paints. However, he makes a pointed remark, stating that "one can paint with them as the Germans do". He emphasises, though, that the same technique can be applied to iron, as well as to stone and glass, provided that the surface should first be treated with an adhesive layer [14, chapters 89, 94 and 103].

The fifteenth century also saw the emergence of copperplate engraving. It did not take long for artists to begin using the beautifully reflective, non-absorbent, and durable plates with smooth surfaces available in urban centres engaged in the printing industry. An example of an oil painting on the reverse of an old printing plate, dated 1659, can be found in the collection of the National Gallery of Art in Washington [3]; a similar but earlier example, using a plate from 1610, is held at Wawel Royal Castle in Poland [6].

As has been demonstrated, over the centuries, there has long been a demand among artists and craftsmen for the decorative colouring of metal objects. Enamelling, known since antiquity, peaked during the tenth-eleventh centuries in Byzantium. The development of enamel art in Western Europe occurred between the eleventh and fourteenth centuries, with major centres in the cities of the Mosan region renowned for their high-quality brass and bronze craftsmanship [17]. At medieval times, enamelling and incrustation were the major techniques of decorating bronze objects [18]. In the sixteenth century, Limoges artists used enamel to create portraits, such as those of members of the Valois royal family, painted on copper and brass plates. Since enamel, once fired, forms a solid and well-adhering layer to the metal surface, it was observed that these paintings showed no signs of deterioration typically associated with the corrosive processes affecting metallic supports [19]. Consequently, enamelling became a key technique that further encouraged using metal plates as supports for oil painting.

In the sixteenth century, white underpainting was replaced by an imprimatur, or coloured underpainting, often in flesh tones. Van der Graaf suggests that copper support provided a ready-made solution for this technique [12].

In the seventeenth century, a fashion for small paintings emerged, which became popular among collectors and adorned the walls of mansions, filling art rooms known as cabinets of curiosities. Copper support provided a cost-effective, market-oriented product catering to the upper-middle classes with limited space and financial resources [20]. At the same time, paintings on metal supports had an aura of nobility and value, and double-sided painting was even allowed [21].

Metal supports were attractive to artists because they could be small, with no limitations on shape, making them ideal for inclusion in "cabinets" and as integral parts of furniture. They were ready-made substrates. Artists did not need to create these supports themselves; they could purchase them from the relevant craftsmen [22]. The plates for painting were thinner than those used for engraving, as the price was determined by the weight of the material [23]. Small panels were durable and easy to transport [20]. These plates were therefore used to create copies of well-known paintings, which conveyed far more than the printed engravings that had dominated until then [24]. Instances are known in which more artists collaborated on a single painting, usually with each being responsible for distinct parts of the image. A noteworthy example of such collaboration can be found in the paintings of the Jesuit artist Daniel Seghers, which were presented as diplomatic gifts by the Jesuit order to monarchs and dignitaries across Europe [25].

From a technical standpoint, metal supports offered perfectly smooth surfaces, allowing for direct painting (as seen in many funeral portraits) or after applying a ground. Various sources suggest using one to three layers of ground, typically composed of linseed oil and lead white; sometimes, the ground was smoothed onto the surface using a finger, leaving a fingerprint impression [20]. These supports provided a luminosity in the painted work that was incomparable to most other surfaces and allowed for depicting even the most minor details [26-27]. A great example of this kind of painting is *A Resting Hare*, by Johann Adalbert Angermeyer, 1732, oil on copper, 31 × 23 cm from National Gallery in Prague. Due to their non-absorbent

nature, painting on metal was more economical, as the paints retained their saturation, and the rigidity of the support minimised the formation of cracks [20].

The durability of metal plates implied mould resistance and woodworm attacks. It was believed that metal supports were more resistant to atmospheric conditions than other substrates, leading to increased use, particularly by joining metal plates. One example is an altarpiece dating from 1639, comprising a central panel, a predella, and two separate paintings in the upper section, which is attributed to Bartłomiej Strobel (1591-1647) and is housed in the Cathedral Basilica of the Assumption of the Blessed Virgin Mary in Włocławek (Figure 1).

Figure 1. Altar copper-support paintings from 1639 by Bartłomiej Strobel (1591-1647) in the Basilica Cathedral of St. Mary of the Assumption in Włocławek, Poland.

It was, however, a foretaste of how artists and craftsmen used the new technique. The museum collections include numerous metal and at the same time polychrome objects, such as sign tags and guild signs, heraldic cartouches, tin sarcophagi, epitaph portraits and tombstones, inscription plaques, votive plaques, miniatures, devotional pictures, elements of armour, votive figures, feretories, Stations of the Cross, clock faces, chests and jewellery boxes, products of the convent craft (trays, plates, platters), sculptures and architectural details (tin, zinc and iron castings). This group also includes objects decorated with monochrome or painted layers.

Paintings on metal supports – self-portrait

Western Europe

As late as the early twentieth first century, scholars had no consensus on where the artist-painter first used a copper plate as a painting support [19]. Echoes of these debates are still present in older publications, where, on the one hand, the Netherlands, with its vibrant craft centre in Antwerp, was emphasised, while on the other, Florence and Rome flourished under the patronage of the Medici family. However, the most recent publications precede Italy, dating the new painting technique to the third quarter of the sixteenth century [4]. Interestingly, Giorgio Vasari (1511-1574), in his work *Lives of the most excellent painters, sculptors, and architects*, while describing the work of Sebastiano del Piombo (1485-1547), writes that he invented painting on stone plates, and in addition, "…showed that one could paint on silver, copper, lead, and other metals" [28]. These techniques flourished in the seventeenth century, also by Northern artists who worked in Italy. Then it spread to other important artistic centres such as Prague, Antwerp, and throughout Europe [26, 29].

> *During the seventeenth century, many of the most important Northern and Italian artists painted on copper at some stage in their careers, including Rubens, Jan Brueghel I, Rembrandt, Hals, Elsheimer, the Carracci, Guercino, Reni, Claude among many others. Karel van Mander wrote about the influence of Northern artists painting on copper in Rome, citing in particular Johann Rottenhammer and Bartolomeus Spranger (Bowron, 1999: 9–30)* [20].

It indicates that these paintings are now primarily found in museum collections, with their themes focusing on portraits, religious scenes, genre scenes, or landscapes.

> *It is further noted: 'The use of copper supports declined during the eighteenth century in Europe. (…) Nevertheless, Canaletto occasionally utilised copper supports, as did the Austrian artists Johann Georg Platzer and Franz Christoph Janneck, who employed them almost exclusively. In the Spanish colonies, the use of copper supports continued to thrive, particularly under the influence of seventeenth-century artists such as Pérez de Alesio, López de Herrera, and Christobal Villalpando* [20, pp. 100-103].

The application of copper supports on the Iberian Peninsula and in Spanish America is further explored in separate studies [22, 30-31].

Central Europe

The development of painting on metal supports from the sixteenth century in Poland (and more precisely in the Kingdom of Poland and the Grand Duchy of Lithuania) took a distinct and particular path. Metal-supported paintings can be found in nearly every church where historical interior furnishings have been preserved. These are most often coffin portraits or epitaphs. These unique objects can also be found in numerous regional, diocesan, and national museums and in the Wawel Castle Complex in Kraków itself [32].

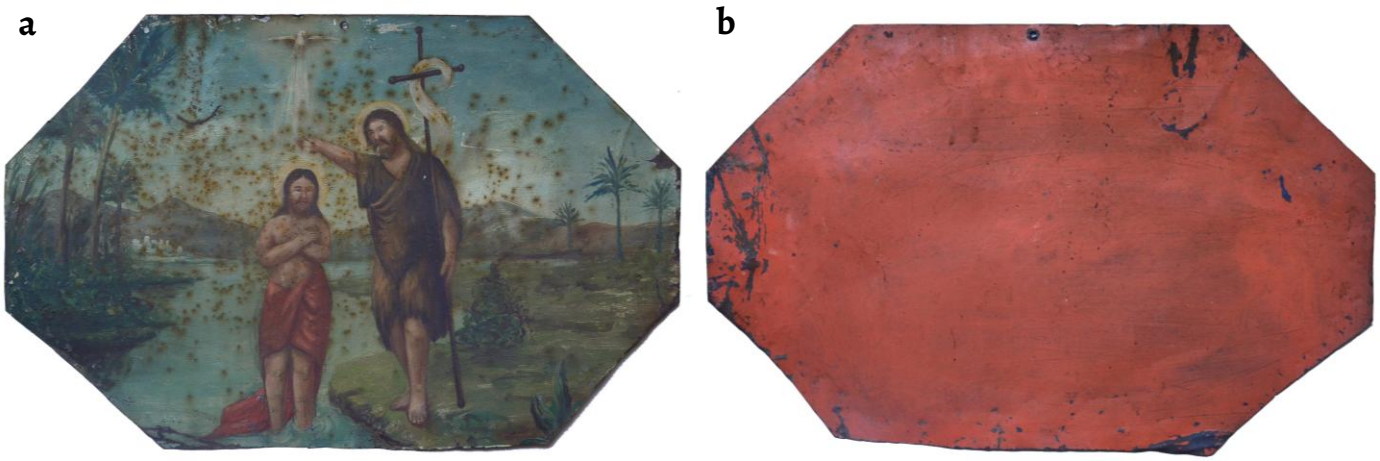

Figure 2.*The Baptism of Christ*, oil on iron, protected with an oil layer on the back of the painting, consisting of a mixture of minium and zinc white, late 19th century, author unknown, private property: *a)* front; *b)* verso.

In the case of Poland, the oldest preserved painting on metal support is the portrait of King Stefan Batory (1533-1586), painted on a copper plate in 1586. Initially, it was located on the lid of a tin sarcophagus made by the Gdańsk pewterer Daniel Gieseler I [19, 32]. What might be interesting here is that King Stefan Batory was the husband of Anna Jagiellon, a daughter of the Polish King and Lithuanian Grand Duke Sigismund I the Old and Italian Duchess Bona Sforza, which may have had a direct impact on the presence of current Italian artistic influences at the royal court.

Coffin portraits are unique objects that do not have direct counterparts in other countries' art. This type of depiction emerged in Poland in the seventeenth century and quickly gained popularity. These portraits were painted using oil paints on copper, tin, or brass plates, often in hexagonal, rectangular, or oval shapes, typically reflecting the form of a coffin head shape [33]. The portrait accompanied the gathered mourners during the funeral ritual and could later be placed with the coffin in the burial crypt or hung on the church wall. Coffin portraits serve as a magnificent source of information about the society and culture of their time. They most often depicted the person as they truly appeared, without idealisation. These portraits were painted after the individual's death and had to be completed efficiently and quickly. As a result, they were often painted directly on the metal plate in a delicate and translucent manner. Coffin portraits were often accompanied by painted or engraved inscription plaques and heraldic cartouches. While anonymous artists typically painted coffin portraits, the accompanying inscriptions usually provide precise dates and locations of their creation. A similar category of memorial objects related to funeral rites includes large funeral banners (examples include the funeral banner of Friedrich von der Groeben at the Wojciech Kętrzyński Museum in Kętrzyn [34] and the banner in the parish church in Szestno [35].

By the late eighteenth and early nineteenth centuries, the use of metal supports had become so widespread that one can speak of folk or lower-middle-class metal painting (Figure 2) [33].

Scale

1972 – J.A. van der Graaf

In his 1972 article, J.A. van der Graaf writes:

> *Joyce Plester has compiled a list of paintings on metal supports in the collection of the National Gallery in London. From the end of the 16th and the first half of the 17th century, there are 13 Netherlandish, 4 German, 7 Italian, and 1 French paintings on metal plates. From the second half of the 17th century, there are only 4 Netherlandish and 1 Spanish painting on metal supports. In the 18th century, the method is only occasionally applied, particularly in France* [12].

This indicates that at that time, there were 30 known artworks on metal plates in the National Gallery (presumably all on copper).

1996 – Vanitas

In 1996, the National Museum in Poznań (Poland), curated by Joanna Dziubkowa, organised the Vanitas exhibition *Funerary portraits in the context of Sarmatian funeral customs*. The exhibition gathered over 400 objects (Table 1) from the territories of the former Polish-Lithuanian Commonwealth. These objects were loaned by 96 institutions and private individuals [19].

Table 1. Number of objects and their support material, described in the exhibition catalogue as oil paintings on metal supports.

Number of objects	Support
339	tin (or tin-lead alloy)
74	copper
27	silvered copper
8	gilded copper
7	silver
2	iron
	silvered iron (or possibly tinned iron?)
1	gilded tin

1998 – Copper as canvas

In December 1998, the exhibition *Copper as canvas: two centuries of masterpiece paintings on copper, 1575-1775*, presented approximately 100 of the most important and well-preserved examples of paintings on copper from collections in the US, Europe, and South America. All the artworks were on copper, including three painted on engraving plates on the reverse side and two as feather mosaics on copper [3].

2003 – Paintings on copper

The *Paintings on copper* exhibition at the Copper Museum in Legnica (Poland) was inspired by an exhibition held in the Czech Republic in 2001: *Věčná malba – Obrazy na kameni a na mědi v 17. a 18. století* (Eternal painting – Paintings on stone and copper in the 17th and 18th centuries) featured objects from Polish and Czech collections. The exhibition showcased 109 works: 48 objects were from three Czech museums, and 61 were lent by 21 Polish museums [6]. Of the 109 paintings made on copper, according to the exhibition catalogue, we can distinguish the types, described in Table 2.

Table 2. Number of objects, their support material and origin, described in the exhibition catalogue as oil paintings on metal supports.

Number of paintings	Support	Origin
98	copper	Italy, France, Netherlands, Germany, Austria, Prague Circle, Silesia, Pomerania, Poland
3	enamel on copper	France
	gilded copper	Poland
	brass	Silesia
1	silvered copper	Poland
	engraving plate	Poland

Based on the differences presented in this chapter regarding how residents of particular regions approach the significance, value, and placement of paintings executed on metal supports, it is possible to offer a general systematization of these aspects, as shown in Table 3.

Table 3. A summary of the chapter about the general differences in the appearance of paintings on metal supports.

Area	Popularity	Material	Artists	Current location	Reasons & value
Western Europe	16th-17th century	Copper supports	Renowned artists	Museum collections	Elements of valuable objects like furniture, parts of cabinets of curiosities, and paintings used for private purposes
Central Europe	17th-19th century	All types of currently available metal supports	Many local artists	Churches and many regional and diocesan museums	Permanent memorial objects, altars, valuable materials, and additional layers (e.g. tinning, gilding and silvering)

Brief characterization of metal supports diversity

Copper / brass / bronze

Much has already been written about copper, and the relevant literature has been extensively cited. However, it is worth noting that most paintings on copper have survived in excellent condition. These works remain mostly unchanged within interior settings. The copper plates were initially hand-forged (hammered), and from the seventeenth century onwards, rolled copper sheets also became common. In 1869, electrolytic copper was introduced [36].

"By the nineteenth century, Mérimée noted that 'painting on copper has been given up for some years' (Mérimée, 1839: 222), yet certain artists developed a particular interest in the potential of copper and other metal plates as supports" [20, pp. 100-103] e.g., Angelica Kauffmann (1741-1807) and William Blake (1757-1827) [5]. The use of copper supports in the twentieth century may have stemmed from a 'modernist' desire to abandon the conventional and experiment with the unorthodox. Joan Miró (1893-1983) and Lucian Freud (1922-2011) used copper plates [37] for a short time in the late 1940s and early 1950s [20, p. 103].

Brass supports were produced using casting techniques. They are not very popular, but surviving examples show they are associated with mining regions or families linked to this industry. An example of this is the painting *Dożynki w majątku Borsigów* (ang *Harvest festival from the Borsig estate*), which was painted on a 1 cm thick brass plate and was intended for semi-external display (in a loggia open on one side), now presented in the National Museum in Szczecin [38]. Coffin portraits from the Silesia region have already been mentioned [6].

No examples of paintings on bronze supports have been identified in the available literature, object catalogues, or conservation documentation. However, this lack of evidence should not be equated with evidence of absence; such objects may exist but have not yet been documented.

Despite this, bronze as a material merits discussion, due to its deep historical association with the development of human civilisation. Following the Copper Age (ca. 6000-3400 BCE), which served as a transitional period between the Neolithic and the Bronze Age, communities with access to tin ores began to produce a new alloy – bronze. This innovation catalysed significant advances in both metallurgy and artistic craftsmanship. Modern-day restorers may encounter bronze objects bearing remnants of polychromy dating as far back as the Shang dynasty (ca. 1600-1050 BCE). At that time, surface decoration focused primarily on applying black or red pigments mixed with lacquer, which were deposited into recessed channels and intaglio motifs on ritual vessels [39]. As time progressed, Chinese artisans increasingly pursued realistic or even naturalistic effects in their surface treatments. A prominent example can be found in the Mausoleum of Qin Shi Huang (third century BCE), where, for example, eight bronze horse sculptures from the imperial chariots were coated with multiple layers of white paint composed of approximately 72 % bone white and 28 % lead white (cerussite) [39]. Partial polychromy is also attested in ancient Egyptian and Greek bronze statuary. Decorative techniques to enhance lifelikeness included inlays of glass and semiprecious stones, gilding, finely painted details, and the strategic combination of different metal alloys [40]. However, it

is important to note that these ancient practices of polychromy on bronze had no direct influence on the development of painting on metal supports in early modern Europe.

Silver

Silver painting is likely as old as painting on copper. It is important to remember that both materials were widely known and used when oil painting techniques spread and developed. Vasari also mentioned it when discussing the work of Sebastiano del Piombo. Later treatises included silver preparation. J.M. Cröker, in his treatise *Der Wohl anführende Mahler* (1764), probably echoed earlier advice when he stated that "silver, brass, copper, tin can be primed or not, or just thinly covered with varnish, and left to dry before painting on it" [41].

Due to the high cost of silver, it was primarily used as a support for small paintings, such as portrait miniatures [33], icon dresses or heraldic cartouches [32]. Silver plates could be either hammered or rolled.

According to Krause [19], paintings on silver are pretty rare, with examples primarily consisting of coffin portraits (several of which are found in the collections of the Jasna Góra Monastery in Częstochowa and the Archdiocesan Museum in Gniezno). Silver supports, especially hammered ones, may show surface delamination of the metal, often appearing as characteristic flakes. This phenomenon reduces the corrosion resistance of the plates. In the case of silver supports, the plates may be joined using a dovetail joint, indicating a high level of craftsmanship.

Lead

According to Krause [19], Jan Hopliński (1887-1974) dates the use of lead as a painting support to the seventeenth century [42]. However, it should be noted that paintings on pure lead supports are rare, and since lead is a low-melting metal, such supports would have been made using casting techniques. In Prague, there is a large painting on a lead plate with a thickness of 4 mm [24]. More commonly, lead sheets were used to cover wooden sculptures exposed to atmospheric conditions. An example is the baroque wooden sculptures on the church's facade in Strzelno, which were covered with lead sheets and coated with a monochromatic layer of paint [19].

Tin / tin-lead alloys

Many authors agree that tin plates, as a support for painting, have been used since the sixteenth century [5, 33, 42]. Interestingly, Bohuslav Slánský (1900-1980) does not mention the existence of tin or tin-lead supports, believing that copper was the dominant metal used for painting until the mid-eighteenth century (followed by iron and galvanised iron) [24].

Tin sarcophagi, common in Poland from the late sixteenth to the seventeenth century, are richly decorated, often gilded, and frequently polychromed examples of pewter craftsmanship. Due to the significance and number of these artefacts, they have been the subject of several comprehensive studies from historical, technological, and conservation perspectives [43-45].

According to Krause [19], other objects of pewter craftsmanship were also painted, such as trays, plates, and hunting scenes on patens. In the Baroque period, natural colours were applied to cast tin sculptures (soldiers, animals), and miniature portraits were painted on many tin objects. Supports made of low-melting metals like tin or lead were typically produced using casting techniques. Seventeenth-century coffin portraits were painted on sheets cast from a tin-lead alloy. Pure tin or lead products would have been too soft and are considered rare. The composition of these alloy supports varies, but they typically contain about 30 % lead [19].

According to Stoner [5], the use of alloy sheets as supports was particularly prevalent in Poland and Austria from the late sixteenth to the late eighteenth centuries, not only for small-scale portraits but also for large altarpieces. A notable example is the high altar in Saint Stephen's Cathedral in Vienna by Tobias Pock (1648), painted on tin support. Tin plates were as durable as copper plates. In the twentieth century, Frida Kahlo used tin supports (1907–1954) [41].

Iron / cast iron / stainless steel

As mentioned earlier in this article, Cennino Cennini writes about oil painting on iron in the fifteenth century. However, painting on iron did not necessarily imply flat images. Literature indicates that in the sixteenth century, iron elements such as wrought iron grilles were painted and gilded [46]. In 2019, such polychromy was discovered on a seventeenth-century grille in the Gdańsk City Hall [47], a similar interpretation is offered by Slánský [24]. Some scholars believe that iron sheets were used as painting supports from the eighteenth century [19, 36], although Krause contends that their use actually began much earlier [19].

According to Losos [48], painting on metal plates was known in the seventeenth century but was not an entirely novel practice. He believes there are armours from the second half of the sixteenth century with colourful decorations and figural paintings. These armours were made of steel but also of copper and tin. He considers oil painting on iron to be suitable for use in environments exposed to weather conditions, such as on signs, memorial tablets, and votive paintings. On the other hand, he argues that iron plates are the least suitable for painting, even though he provides a method for their preparation [48]. Slánský [24] observes that iron has been the most widely used metal since the Middle Ages, but it corrodes quickly, so he believes that stainless steel is a better alternative.

Cast iron – paintings on cast iron plates are found in architectural tombs and cemetery chapels. These castings have rough and porous back surfaces, which worsen their corrosion resistance and structural integrity [19].

After Cross and Horovitz [41], “steel (iron alloys) and stainless steel were occasionally selected by painters. […] Steel, like aluminium, becomes more corrosion-resistant once coated or painted, and remains stable, especially in museum conditions. Any paint applied as a primer should not contain elements that could react with the alloys in the support. Iron-containing sheets are particularly vulnerable and corrode in the presence of oxygen and humidity, which can cause the paint layers to lift”.

Zinc

Zinc is the first metal in our series that has not been used in its pure form since ancient times. Zinc was most often used as a component of brass when smelted with copper and lead as an alloying metal [49]. Metallic zinc was first isolated in India around the year 1300. It was subsequently imported into Europe, where it was not until the mid-eighteenth century that pure zinc was successfully obtained from calamine. The Czech Rococo painter Norbert Grund left behind several works executed on zinc supports as early as 1750. “In 1798, Johann Christian Ruberg developed the first large-scale method for producing pure zinc metal (horizontal muffle furnaces), which led to the growth of a large zinc manufacturing industry in Silesia [50]. In the first two decades of the nineteenth century, zinc sheets became an alternative to copper and lead sheets in the roofing sector [51]. From that moment on, artists also started to use zinc sheets as painting supports” [52].

Janusz Krause cites Jan Hopliński, who also confirms that painters began using zinc sheets as supports in the early nineteenth century [19, 42]. An example of altarpieces on zinc supports includes three paintings by Adolf Herman Duszek, belonging to the parish in Wola Kiełpińska (Zegrze), near Warsaw [53] (Figure 3). Detailed research on one of these paintings documented that it had been repainted twice [52, 54]. This characteristic of metal supports is often overlooked, but they can be reused over time due to their durability, sometimes greater than the painted surface.

After Cross and Horovitz [41]: "Zinc, which has been used occasionally as a support since the nineteenth century, does not generally corrode when kept in a clean and stable environment below 70 % RH, and is protected to some extent by cohesive paint layers. When exposed to acidic or alkaline conditions, zinc can dissolve, but when exposed simply to air, zinc forms a thin transparent film of zinc oxide and maintains its bluish-white, lustrous appearance".

Figure 3. *The Sacred Heart of Jesus*, by Adolf Herman Duszek, oil on zinc, 174.5 × 83.0 cm, parish in Wola Kiełpińska (Zegrze), after conservation and restoration (the original painting was created between 1895 and 1899, and then repainted twice in 1924 and 1950): *a)* verso; *b)* front.

It is worth mentioning that zinc supports were also used in the Far East. The National Gallery in Singapore collection includes Burmese oil paintings from the early twentieth century (c. 1918), executed on zinc panels and depicting royal family members [55]. Even though there are not many examples of paintings on zinc supports, by the twentieth century, lighter and more durable aluminium and magnesium supports proved to be a better option [41].

Aluminium

All twentieth-century authors cited in this publication have recommended and praised aluminium supports in painting. Many of them describe various methods for preparing such supports [48], while Max Doerner advocated the use of factory-passivated aluminium panels known as *eloxal* [56].

After Cross and Horovitz [41]: "Aluminium is one of the most abundant metals in the earth's crust but, as it was isolated only in 1825, it was not available for commercial use until after 1886 in the United States and Europe; the onset of World War I drove the development of aluminium and its alloys in the early twentieth century. (…) Frank Stella (b. 1936) and other twentieth-century artists worked on aluminium supports".

Currently, within the tradition of magical realism, Zbigniew Oporski is one of the examples of the artists who create their paintings on aluminium supports nowadays [57].

Magnesium

Magnesium supports are mentioned in only one of the technical publications referenced here: "…It was during this decade that magnesium alloys began to replace zinc and zinc alloys as etching plates. Swan Engraving recommended the magnesium sheet to Stella as a suitable etching surface and rigid painting support (Laibinis-Craft, 2005: 256). Long Beach, 1982 (National Gallery of Art, Washington, DC)…" [41]. One could say that history came full circle at the turn of the twentieth and twenty first centuries, when artists such as Frank Stella once again embraced modern materials, lightweight and durable metals, as supports for colourfully treated surfaces, often incorporating sculptural elements as well [58].

Additional layers – gilding / silvering / tinning / zinc coating

Metal painting supports could be covered with additional metallic layers for two primary purposes: to protect the metal from corrosion, give it a more noble appearance, or a different colour, or both properties were sought simultaneously.

In the twelfth century, Theophilus Presbyter describes the process of tinning copper and iron by immersion [13, Book III, chapters 72 and 92], so the plates were usually tinned on both sides. The tinning process can also involve heating the dried and degreased base plate to 300 °C and covering the surface with finely powdered tin, which becomes molten and spreads across the surface.

The oldest known oil painting on a tinned copper support dates from the late sixteenth century, *Portrait of Cardinal Savelli* (1522-1587), by Scipione Pulzone [59].

In the twentieth century, many authors discussed iron tinplates. For example, Slansky argues that in the eighteenth century, iron sheets, bleached and coated with tin on both sides, were commonly used. However, he points out that due to the different coefficients of thermal expansion of the two materials, the tin coating can detach from the iron [24]. Krause mentions that a significant group of preserved works from the nineteenth century was made of tinned iron, such as Our Lady of the Rosary and Saint Peter from the Museum in Bochnia [33]. An example of such a painting is a copy of Madonna del Dito from a private collection (Figure 4) [60]. From the late eighteenth century, tin-plated iron sheets were used in the Spanish Colonies for the mass production of devotional paintings called *retablo*. This tradition later became a significant source of inspiration for Frida Kahlo's work.

Losos [48] believes that galvanised steel was used from the eighteenth century and was still used in the nineteenth century. Slansky notes that a zinc coating on iron is an even worse choice than tin, as it does not provide proper adhesion for painting. Therefore, he does not recommend either of these types of support [24], and Werner shares the same opinion [36].

Figure 4. *Madonna del Dito*, a copy of a painting by Carlo Dolci (1616-1686), oil on tinned steel, author unknown, 26.3 × 20.6 cm, private property, after conservation and restoration: *a)* front; *b)* verso.

Gilding and silvering

The presence of gilding on paintings with metal supports is documented in literary sources, and there are known examples of such objects, including funeral portraits and 3 paintings by Rembrandt, where the background is covered with gold leaf [20, pp. 100-103].

Both Horovitz [61] and Schmid [59] believe that true silvering does not occur on supports used for oil painting. They consider the "silver" appearance of decorative layers to be tin coatings, as these are the only objects they have encountered. Based on the referenced catalogue listings (coffin portraits and coat-of-arms plaques) and the example of a personally examined coffin portrait (Figure 5), I wish to clarify this situation and show that such supports do exist. The painting examined is a coffin portrait, part of the collection of the Diocesan Museum in Toruń. XRF analysis revealed that the copper support is covered with a layer of silver, likely applied using fire silvering, as a significant amount of mercury from amalgam was also detected. Other rare examples can be found in the Archdiocesan Museum in Gniezno, where at least two coffin portraits of men have been made on silvered brass.

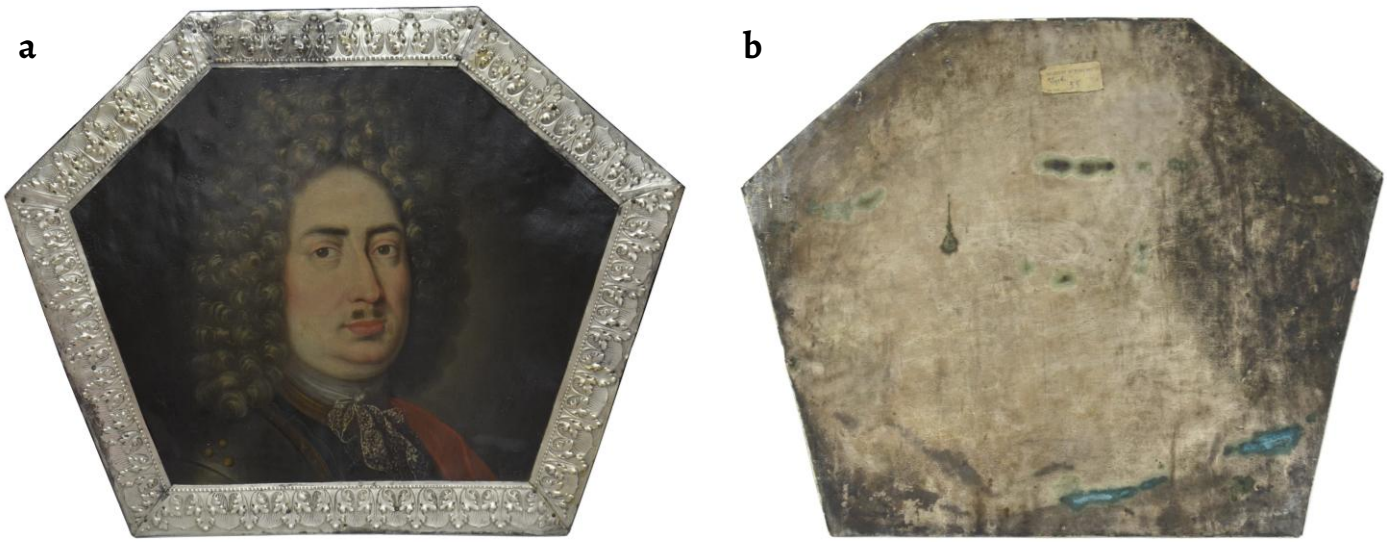

Figure 5. *Coffin portrait,* oil on silvered copper, Diocesan Museum in Toruń: *a)* front; *b)* verso.

Conclusions

Based on the material provided, it is evident that the use of various metal supports in painting has evolved significantly over time, with each metal offering unique advantages and challenges for artists and conservators. From ancient practices of applying metallic layers for aesthetic or protective purposes to the refined use of metal as a primary support for oil painting, the choice of metal support was often dictated by both practical and artistic concerns. The introduction of metals such as copper, tin-lead alloys, zinc, and iron, and their subsequent treatment with additional layers like gilding or silvering, and tinning marked a crucial development in the history of painting materials. Metal panels offered durability and resistance to environmental factors, making them ideal for artworks exposed to harsh conditions. In the sixteenth and seventeenth centuries, metal was commonly used for coffin portraits and memorials, reflecting a desire for permanence and reverence in commemorative art. Central European artists played a key role in this tradition, producing large altarpieces and many smaller works of art on different metal supports. As the presented examples have shown, painting on metal supports did not disappear in the eighteenth century; on the contrary, many contemporary artists continue to explore and employ this technique to this day. In conclusion, metal supports have played an important role in the evolution of painting, with ongoing challenges and innovations influencing their use as painting supports. The continued exploration of their properties and preservation techniques ensures their relevance in contemporary conservation and artistic practices.

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