Characterisation and Degradation Analysis of Two Metallic Threads in Malay Textiles from the Department of Museums Malaysia using Visual and Scientific Approach

Sharifah Tahirah Syed Kamarulzaman[1]*, Basitah Taif[2], Muhammad Ismail Ab Kadir[3], Rajabi Abdul Razak[2]

[1]Department Applied Arts and Design, Faculty of Architecture and Environmental Design, International Islamic University Malaysia, Jalan Gombak, 53100, Selangor, Malaysia

[2]Department Textile Design, Faculty of Art and Design, College of Creative Arts, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

[3]Department Textile Science and Fashion Technology, Faculty of Applied Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, Malaysia

DOI: https://dx.doi.org/10.47772/IJRISS.2024.8120106

Received: 30 November 2024; Accepted: 05 December 2024; Published: 04 January 2025

ABSTRACT

This paper aims to identify and investigate the characteristics and degradation of two metallic threads from two traditional Malay textiles using visual examination and a scientific approach. The case studies belong to the Department of Museums Malaysia, which dated back before the 20th century. The examination was carried out using handheld digital microscopy and SEM-EDX (Scanning Electron Microscopy, Energy Dispersive X-Ray) analysis. The threads, consisting of a thread core wrapped with metallic strips, were found to incorporate gold and silver. Degradation included flaking, peeling, and core exposure, primarily driven by environmental factors and mechanical wear. This research emphasises the significance of combining visual examination and SEM-EDX analysis to understand the characteristics and material properties and inform conservation efforts for preserving Malay textile heritage.

Keywords- Malay textile artefact; metallic threads; microscopic; degradation; SEM-EDX

INTRODUCTION

Metallic threads are used in *Malay* textile weaving, such as on *songket* and *limar songket*. It is an important element in creating motifs and patterns in *songket* as a supplementary weft (Norwani Nawawi, 2002). She explained that supplementary weft is a weaving technique in which ornamental weft yarns are woven between two regular weft yarns to create the desired designs and motifs. The metallic threads are inserted between the silk or cotton weft threads in the weaving process. The amount of gold patterning in each length of cloth varies. According to Azah Aziz (2009), a *songket* must include metallic yarns in the whole composition, even in a small amount. Without the metallic yarn patterning, the textile cannot be called a *songket* (Stankard, 2010; Azah Aziz, 2009). Visually, the contrast in texture between the background cloth and the metallic motifs is more noticeable since the gold thread is rounded (Selvanayagam, 1990).

Moreover, metallic threads stand out against the background textile to create a shimmering and gleaming effect. In the past, *songket* often had dark backgrounds such as maroon, blue, black and purple (Norwani Nawawi, 2002). This is because the weavers aimed to create a contrast between the background and the metallic thread used for the patterns and emphasise the gold thread's richness. *Songket* and *limar songket* with metallic thread on a silk ground is the pride and greatest of Malaysian weaving and is usually reserved for the high society.

Traditionally, real gold was originally used as supplementary weft yarns in *songket* motifs (Maxwell, 1990; Selvanayagam, 1990; Norwani Nawawi, 2002). Strips of gold and silver are tightly wrapped around the cotton core yarn (Stankard, 2010). Norwani Nawawi, personal communication (2022), claimed that traditional

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XII December 2024

songket metal threads use gold or silver strips wrapped around silk threads. On the other hand, she highlighted that metal threads were also made from copper dipped in gold. The metallic threads are also believed to have been brought into the archipelago by Indian traders (Siti Zainon Ismail, 1997; Maxwell, 1990). Maxwell (1990) and in agreement with Stankard (2010), gold threads were used widely in local *songket* weaving. However, due to the weight of the supplementary gold weft and soaring cost, it was no longer practical for real gold to be used for clothing (Siti Zainon Ismail, 1997; Norwani Nawawi et al., 2015; Stankard, 2010). Real gold was replaced by metallic wires or strips.

Meanwhile, silver was soon incorporated as a supplementary weft yarn. Similar to gold, silver has been used on *songket* as a supplementary weft for centuries. The metallic threads are divided into two basic types: wires-rolled strips and cut strips (Stankard, 2010).

Shortly after, synthetic gold, silver, and metallic yarns were introduced to songket weaving in the early 20th century. The yarns were imported from India and soon replaced the real gold and silver supplementary weft. The replacement of synthetic metallic yarn is due to its low cost compared to the real gold and silver threads. Even though synthetic metallic yarns are used on songket nowadays, the textile symbolism and beauty remain exclusive (Maznah Mohamad, 1996). Nowadays, the songket is still highly valued and exclusive. The textile is more esteemed and valuable if more metallic yarns and finer motif patterns are incorporated throughout the surface (Maxwell, 1990, as cited in Stankard, 2010).

METHODOLOGY

Two textile artefacts were chosen as case studies as shown in fig. 1 and 2, where case study 1 (CC1) is sourced as artefact E1978.1963.CEW.40 and case study 2 (CC37) sourced as artefact E236.1976.PM2.(b)28. Both artefacts are maroon traditional Malay Songket; however, the structure and form are different. CC1 is a *sarong Songket*, whereas CC 37 is *a kain lepas Limar Songket*. The artefacts' age is unknown. However, the CC1 acquisition year was 1963, and the CC37 acquisition year was 1976. Small fragments of broken threads or loose fibres from the artefacts were taken to understand artefacts further. The study method is divided into visual examination and scientific analysis.

Figure 1: Case study 1 (CC1)- E1978.1963.CEW.40

Figure 2:Case study 2 (CC37) - E236.1976.PM2.(b)28

A. Microscopic Analysis

Visual examination is the first step in studying the condition of the textile artefact. It determines the characteristics of the material and the object's history based on the evidence of its physical condition. International Council of Museums (ICOM) (2004) stated in the code of ethics for Museums that museum artefact collections should be documented according to accepted professional standards. Both artefact samples

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XII December 2024

were carefully observed under a *Celestron* Digital handheld Microscope with approximately 20x magnification and a digital image was captured before scientific analysis. Microscopic analysis was used to identify and closely inspect the degradation and any other occurrence of the textile artefact.

B. Sem Edx

A Scanning Electron Microscope (SEM) can be utilised for high-magnification imaging of almost all materials. The instrument is suitable for different kinds of investigations that can investigate the fibre structure. SEM combined with Energy-dispersive X-ray spectroscopy (EDS or EDX) is an analytical technique used for a sample's elemental analysis or chemical characterisation. Its characterisation abilities are because each element has a unique atomic structure. It allows X-rays to be identified uniquely from each other (Tamburini 2019; Osman et al. 2014). With SEM combined with EDX, it is also possible to determine what elements are in different parts of a sample. The output of EDX analysis is a spectrum. The higher the spectrum peak obtained, the more concentrated the element is in the sample.

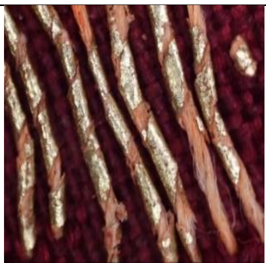
The SEM - EDX analysis was conducted at Quasi-S Technology Sdn Bhd. Each sample was placed uncoated on an adhesive carbon tape mounted onto an aluminium SEM stub, VP SEM (Hitachi SU-1510), using the backscatter electron (BSE) detector at 16 kV. The preferred working distance was from 7 to 15 mm (as required). The SEM chamber vacuum setting was at 50 Pa. The EDX instrument used was Oxford Xplore 30 AztechOne. The parameters used for the examination were the same as described above, except for the working distance, which was kept at 15 mm, which is optimal for EDX analysis. EDX spectra were acquired for 1 – 2 min in the energy range 0–15 eV and with the number of counts up to 2000-3000. The magnification image used for the SEM-EDX examination spot ranged from x100 to x450.

RESULTS AND DISCUSSION

A. Characterisation- Visual Examination

The metallic threads are used on songket and limar songket. It is observed that the structure of the songket metallic thread uses the wrapping technique (Table 1). According to Stankard (2010), the metallic thread is made from flattened real gold or silver strips and is tightly wrapped around a core yarn of cotton. The density of this type of metallic hand-spun thread is varied from less than 1 millimetre to 2 millimetres (Stankard 2010). This type of metallic thread was brought into the archipelago by Indian traders (Maxwell 1990; Siti Zainon Ismail 1997). However, according to Norwani Nawawi (2022) and Janpourtaher (2019), the gold strips are wrapped around silk threads to form a metallic thread for the songket.

Table 1: The microscopic image of metallic threads wrapping technique.

No.	Sample No.	Microscopic Image x20	Twist style
1.	CC1		 Z
2.	CC37		

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XII December 2024

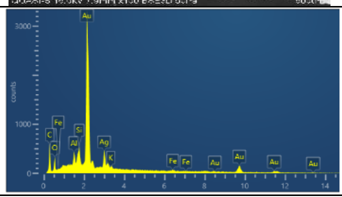
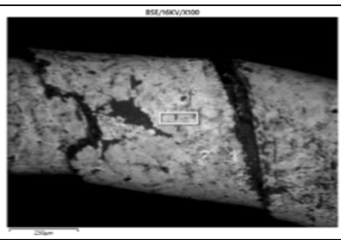
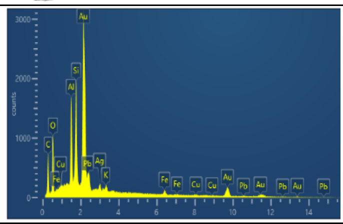
Shibayama et al. (2015) state that most metal-wrapped threads use thin metal strips wrapped around a fibre core. Jaro (1990) and Garside (2002) explained that this technique of producing metallic thread was used around the early 19th century. It is explained that the gold foil is bonded to the paper or mounted on a stick surface and cut into thin strips of about 0.5 mm to 0.6mm to form a flat gold thread, and then the flat gold thread is wrapped around a cotton or silk thread to form a round gold thread. This technique was first used in colonial textiles from the Andes (Muros et al. 2007). The technique was then introduced to China and was later spread to other countries, such as Malaysia.

All metallic threads are wound in the respective opposite direction around the core fibre. Therefore, when core threads are twisted with s-spun, the metallic threads are twisted with z-spun (Muros et al. 2007). The same technique was applied to songket weaving, which confirmed Janpourtaher's (2019) findings.

B. Characterisation -SEM-EDX

The SEM results for the samples' surface morphology in Table 2 revealed that the gold threads are made of metal leaf wrapped around the fibre core. The magnification images show that strips were made of metal-coated paper wound around a fibre core. The wrapping material of the metal-coated paper adheres to the core entirely from the twist technique (Indictor and Blair 1990). As mentioned in the visual examination result, the s-twist technique is usually tightly coiled around the core fibres, exposing little or no core fibre.

Table 2: SEM-EDX metallic threads' results

<table>
<tr><th colspan="6">X450</th><th colspan="4">Element</th></tr>
<tr><td colspan="10">CC1</td></tr>
<tr><td colspan="10"></td></tr>
<tr><td colspan="10"></td></tr>
<tr><td colspan="10">Weight (%)</td></tr>
<tr><td>O</td><td>Al</td><td>Au</td><td>Ag</td><td>Pb</td><td>K</td><td>Si</td><td>Fe</td><td>Cu</td><td>C</td></tr>
<tr><td>11.32</td><td>5.63</td><td>46.88</td><td>2.57</td><td>5.63</td><td>0.87</td><td>6.71</td><td>2.05</td><td>1.06</td><td>17.29</td></tr>
<tr><td colspan="10">CC37</td></tr>
<tr><td colspan="10"></td></tr>
<tr><td colspan="10"></td></tr>
<tr><td colspan="10">Weight (%)</td></tr>
<tr><td>O</td><td>Al</td><td>Au</td><td>Ag</td><td>Pb</td><td>K</td><td>Si</td><td>Fe</td><td>Cu</td><td>C</td></tr>
<tr><td>5.18</td><td>1.36</td><td>63.73</td><td>10.13</td><td>-</td><td>0.44</td><td>1.70</td><td>0.80</td><td>-</td><td>16.66</td></tr>
</table>

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume VIII Issue XII December 2024

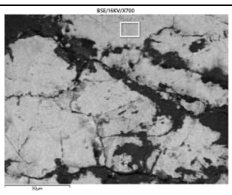
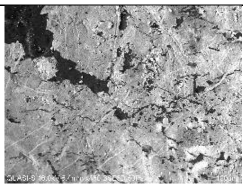
This metal thread production technique was commonly found in Indian and Persian textile artefacts and was known to be widely imported from China and India ((Shibayama et al. 2015b) Indictor and Blair 1990). This is a common characteristic found in Southeast Asian textiles (Janpourtaher 2019). This type of metallic thread could be gold, silver, or even copper alloys. The core fibres are typically silk and sometimes cotton. It is also proven by the claims made by Norwani Nawawi (2022) that traditional songket metal threads use gold or silver strips wrapped around core threads. According to Garside (2002), this type of metal thread was widely used around the 5^{th} century in the Middle East and Eastern Mediterranean regions. Later, the production of these metal threads was replaced with a new technique in the 1930s (Láró et al. 2013).

The EDX results presented in Table 2 revealed the 2 metallic threads of metal elements. The gold (Au) detection has the highest weight % on the metal-wrapped threads for both samples. The interpretation of the result is that the metallic thread samples were covered with gold foil on a core-based fibre. Moreover, silver (Ag) is also present in both samples. Járó and Tóth (1991) also stated that if silver is detected beside gold, it can be assumed that the silver was gilded by heat, where welding of gold leaf and silver results in the formation of a gold-silver mixture on the layer surface. Muros et al. (2007) revealed that the results of the 17^{th}-19^{th} century metal threads from the Colonial Andes EDX show that the studied metal thread is a gold-coated silver strip around the core fibre.

In addition, according to Koestler et al. (1989) and in agreement with Cheung et al. (2021), metallic thread such as gold wrapped with silver uses backside material as support which can possibly be an adhesive layer such as paper for binding the metal foil with the base core. This suggested that the metallic thread is made of gold foil metal-coated paper wound around a fibrous core. On the other hand, according to Janpourtaher (2019), the detection of carbon and oxygen indicates cotton yarn inside the metal thread. Therefore, it confirms that the base core of the metallic thread uses cotton threads. However, other detected elements, such as copper (Cu), potassium (K), and lead (Pb), could be an indication of the backside detection that needs further investigation.

C. Degradation

Table 3: Microscopic and SEM metallic threads' anlaysis results

Instrument	**CC1**	**CC37**
Microscope (x20 magnification)		
SEM (x700 magnification)		

The visual examination of the detected samples showed that the metallic threads were in bad condition. The degree of degradation varies from one artefact to another. It is observed that there are minor abrasions and loosening of threads. Evidence of flaking and core exposure can be observed in microscopic images, as depicted in Table 3.

Moreover, some areas experienced peeling and flaking that caused the separation of small, thin pieces of a coating from its substrate. Flaking is generally due to a combination of adhesion loss and cracking (Timar-Balazsy and Agnes 1998). It is most likely due to a photochemical reaction and thermal factor. These factors are caused by unsuitable humidity and temperature, where the fibre becomes brittle and fragile. Furthermore, according to Garside (2002), the peeling and flaking of metallic threads' thin outer layers are due to mechanical damage. The damage occurred when abrasion happened on the thin layer of metallic coating or metallic leaf.

Moreover, due to mechanical damage over the years of flexing and straining the fabric, the samples experience a loose and weak twist that reveals the cotton core. Stankard (2010) explained that the problem with this type of hand-spun metallic yarns is their tendency to be damaged while donning the fabric. The gold strips wrapping the cotton core would weaken and break, revealing the yellow cotton underneath.

On the other hand, based on the 700x magnification from SEM analysis, both metal threads experience degradation. The result shows cracking and flaking of the gold foil of the metallic thread shown in Table 3. The peeling and flaking of metallic threads' thin outer layers are due to mechanical damage. The damage occurred when abrasion happened on the thin layer of metallic coating or metallic leaf. These degradations are most likely due to abrasion of the thin gilding layer caused by human factors. Indictor and Blair (1990) stated that this type of thread is usually more likely to be problematic. Stankard (2010) explained that the problem with this type of hand-spun metallic yarns is their tendency to be damaged while donning the fabric. Due to the mechanical damage over the years of flexing and straining the fabric, the textile experiences a loose and weak twist, revealing the cotton core. The gold strips wrapping the cotton core would weaken and break, exposing the yellow cotton underneath. According to Vargas and Jiménez (2011), the usage and handling of the textile promote severe damage, such as abrasion of the thin gilding, cracks of the metallic filaments and an increased tear of the textile fibres.

CONCLUSION

The analysis of two metallic threads from traditional Malay textiles has provided critical insights into their material composition and degradation patterns. Both threads were found to be constructed with a cotton core wrapped in metallic strips, primarily composed of gold and silver. Visual examination revealed significant signs of wear, including flaking, peeling, and core exposure, while SEM-EDX analysis identified the presence of additional elements, such as copper and lead, which may have contributed to their deterioration. These findings emphasise the vulnerability of metallic threads to environmental factors such as humidity and mechanical stress over time.

The study highlights the importance of combining visual and scientific techniques to assess and understand the characteristics and degradation of heritage materials. This integrative approach is essential for developing effective conservation strategies that ensure the longevity of these culturally significant artefacts. Recommendations include storing the textiles in controlled environments, minimising physical handling, and considering protective treatments to stabilise the condition of the metallic threads.

Future research should expand on the impact of material composition, such as the role of copper content in accelerating corrosion, and explore similar artefacts to establish a broader database of material properties. This effort will support the ongoing preservation of Malay textile heritage and the continuation of its historical and cultural narrative.

ACKNOWLEDGEMENT

The authors acknowledged the reference materials and assistance obtained from the Department of Museums Malaysia, also known as *Jabatan Muzium Malaysia (JMM)*. Deepest appreciation to the museum's staff for their valuable help and guidance to the researchers. The authors would also like to thank the lab assistant in Quasi-S Sdn. Bhd. for assisting the researchers during the SEM-EDX analyses.

REFERENCES

1. Aziz, A. (2006). Rupa & gaya busana Melayu. Penerbit Universiti Kebangsaan Malaysia.
2. Ballard, M., Koestler, R. J., & Indictor, N. (1986). Weighted silks observed using energy dispersive X-ray spectrometry. Scanning Electron Microscopy, 1986(Part 2), 499–506.
3. Boersma, F., Brokerhof, A. W., van den Berg, S., & Tegelaers, J. (2007). Unravelling textiles: A

handbook for the preservation of textile collections. Archetype Publications.

4. Cheung, A., Solazzo, C., & Tsui, W. S. (2021). Unveil the gold: Revealing metal threads and decorative materials of early twentieth-century traditional Chinese children's hats. Studies in Conservation, 66(6), 357–374. https://doi.org/10.1080/00393630.2020.1854894
5. Garside, P. (2002). Investigations of analytical techniques for the characterisation of natural textile fibres towards informed conservation (Doctoral dissertation). University of Southampton.
6. Garside, P., & Wyeth, P. (2007). Use of polarised spectroscopy as a tool for examining the microstructure of cellulosic textile fibres. Applied Spectroscopy, 61(5), 523–529. https://doi.org/10.1366/000370207780807821
7. Geminiani, L., Campione, F. P., Corti, C., Motella, S., Rampazzi, L., Recchia, S., & Luraschi, M. (2021). Unveiling the complexity of Japanese metallic threads. Heritage Science, 9(1), 17. https://doi.org/10.1186/s40494-021-00523-8
8. International Council of Museums. (2004). Code of ethics for museums. https://icom.museum
9. Indictor, N., & Blair, A. (1990). The examination of metal from historic Indian textiles using scanning electron microscope-energy dispersive X-ray spectrometry. Textile History, 21(2), 149–163.
10. Ismail, S. Z. (1997). The traditional Malay handicraft design. Dewan Bahasa dan Pustaka.
11. Járó, M. (1990). Gold embroidery and fabrics in Europe: XI–XIV centuries. Gold Bulletin, 23(2), 40–57. https://doi.org/10.1007/BF03214711
12. Maxwell, R. J. (1990). Textiles of Southeast Asia: Tradition, trade, and transformation. Australian National Gallery.
13. Mohamad, M. (1996). The Malay handloom weavers: A study of the rise and decline of traditional manufacture. Institute of Southeast Asian Studies.
14. Muros, V., Wärmländer, S. K. T. S., Scott, D. A., & Theile, J. M. (2007). Characterisation of 17th–19th century metal threads from the colonial Andes. Journal of the American Institute for Conservation, 46(3), 229–244. https://doi.org/10.1179/019713607806112590
15. Nawawi, N. (2002). Songket Malaysia. Dewan Bahasa dan Pustaka.
16. Nawawi, N., & Dewan Bahasa dan Pustaka. (2016). Ikat limar: The ancient Malay textile. Dewan Bahasa dan Pustaka.
17. Nawawi, N., Aziz, A., Legino, N., Ahmad, R., & Ismail, N. (2015). The nature of Malay songket textile. Business and Management Quarterly Review, 6(March), 41–56.
18. Osman, E., Zidan, Y., & Kamal, N. (2014). Using the microscopic and spectroscopic techniques to identify and characterise archaeological artefacts. International Journal of Conservation Science, 5(1), 459–468.
19. Portella, E. H., Romanzini, D., Angrizani, C. C., Amico, S. C., & Zattera, A. J. (2016). Influence of stacking sequence on the mechanical and dynamic mechanical properties of cotton/glass fiber reinforced polyester composites. Materials Research, 19(3), 542–547. https://doi.org/10.1590/1980-5373-MR-2016-0058
20. Selvanayagam, G. I. (1990). Songket: Malaysia's woven treasure. Oxford University Press.
21. Shibayama, N., Wypyski, M., & Gagliardi-Mangilli, E. (2015). Analysis of natural dyes and metal threads used in 16th–18th century Persian/Safavid and Indian/Mughal velvets by HPLC-PDA and SEM-EDS. Heritage Science, 3(1), 37. https://doi.org/10.1186/s40494-015-0037-2
22. Stankard, S. (2010). Textile praxis: The case for Malaysian hand-woven songket (Doctoral dissertation). Royal College of Art.
23. Tamburini, D. (2019). Investigating Asian colourants in Chinese textiles from Dunhuang (7th–10th century AD) by high-performance liquid chromatography tandem mass spectrometry. Dyes and Pigments, 160, 75–90. https://doi.org/10.1016/j.dyepig.2018.12.025
24. Timar-Balazsy, A., & Eastop, D. (1998). Chemical principles of textile conservation. Butterworth-Heinemann.
25. Vargas, I. K. J. C., & Contreras, J. (2011). Gilded silver threads: Corrosion and cleaning. Academia.edu. https://www.academia.edu/16758170