The Bust of Lenin by Memos Makris: Forms of Corrosion and Conservation Work

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Abstract: The bust of Lenin by Memos Makris has been located in front of the offices of the Communist Party of Greece since 1986. The sculpture is made of copper sheet 1,5 mm thick. Small pieces of copper sheet hammered to take the appropriate form are welded together. The eyes are made of murano glass in the shades of white, blue, red and brown. The whole sculpture has been patinated by a solution of potassium sulfide and a protective wax coating has been applied.

The influence of more than 15 years of urban atmosphere has had its affect on the sculpture: A layer of precipitated small particles of soot, dust and other materials is forming strongly adhering crusts in places protected from rain. In other places artificial patina has been removed by acid attack and the welded joins have been subject to galvanic corrosion. The disfiguring "drainings", a characteristic form of corrosion in outdoor bronze statues, is also present in places. This form of corrosion is due to the condensation of water vapour, the dissolution of acid pollutants in water droplets and the subsequent acid attack of the artificial patina.

Conservation work started by thorough washing of the whole sculpture from the top downwards. Tap water was used at the beginning subsequently followed by deionized water. Non-ionic detergent was used for the removal of greasy precipitates. During washing pH and conductivity was measured. For the removal of the hard black crusts, absorbing clay was used together with water and a solution of EDTA. This absorbing pad, through dissolving calcium compounds, weakens the hard crusts and makes their removal by mechanical means much easier. In places, disfiguring corrosion products were removed by mechanical means.

Old remnants of wax were removed by repeated treatment with solvents. It is well known that old wax is not easily removed. In small places, when necessary after cleaning, the artificial patina was restored. At the end a protective layer of microcrystalline wax was applied.

Περιληψη: Η προτομή του Λένιν φιλοτεχνήθηκε από τον Πατρινό γλύπτη Μέμο Μακρή τη δεκαετία του 70. Το 1986 τοποθετήθηκε στο κτίριο της Κεντρικής Επιτροπής του Κ.Κ.Ε., στον Περισσό.

*Η προτομή, διαστάσεων 1,80m ύψος, **1,40m πλάτος και 1,40m μήκος είναι κατασκευασμένη από κομμάτια φύλλων χαλκού 1,5 mm** πάχους, κατάλληλα μορφοποιημένα, σφυρήλατα και συγκολλημένα μεταξύ τους με χαλκοκόλληση. Ιδιαίτερης σημασίας και τεχνικής στο έργο είναι η απόδοση των ματιών από γυαλί μουράνο σε λευκό, αποχρώσεις του μπλε, κόκκινου και καφέ. Το έργο έχει πατιναριστεί με τη χρήση διαλύματος θειούχου καλίου (K_2S) **και έχει περαστεί με κερί.***

Η εμφάνιση της προτομής έχει αλλάξει μετά από 15 χρόνια έκθεσης σε ένα διαβρωτικό περιβάλλον με ατμοσφαιρική ρύπανση, όπως αυτό της Αθήνας. Επικαλύπτεται από σκόνη και άλλα σωματίδια λεπτού πάχους που προέρχονται από τον περιβάλλοντα χώρο. Η τεχνητή πατίνα έχει απομακρυνθεί σε αρκετά σημεία, κυρίως σε ακμές και στις πιο εκτεθειμένες περιοχές. Κατά τόπους εμφανίζει απώλεια της διαφάνειάς του και θόλωμα (γαλακτώδης εμφάνιση), ενώ σε σημεία που δεν ήταν εκτεθειμένα στη βροχή είχε σκούρα καφέ απόχρωση. Η αλλοίωση οφείλεται πιθανότατα σε διαδικασίες διάβρωσης υπό την επίδραση, κυρίως, της υγρασίας και των αέριων ρύπων. Σημαντικό ρόλο στη γαλακτώδη εμφάνισή του φαίνεται να είχε η προσρόφηση αιωρούμενων σωματιδίων. Η σκούρα απόχρωση μπορεί να αιτιολογηθεί από την επικάθιση και την προσρόφηση σωματιδίων (π.χ. αιθάλης). Η φθορά του προστατευτικού υλικού είχε αλλοιώσει σημαντικά τις ιδιότητές του, δημιουργώντας αισθητικά προβλήματα και διάβρωση του χαλκού. Το πιο εμφανές σύμπτωμα της επίδρασης των παραγόντων φθοράς στο γλυπτό, είναι τα ''ίχνη ροής" που εμφανίζονται κυρίως σε περιοχές που δεν εκτίθενται άμεσα στην βροχόπτωση (βλέφαρα, αυχένας, το κάτω σημείο της μύτης κ.λπ.). Αυτό το είδος της διάβρωσης οφείλεται στη συμπύκνωση υδρατμών. Τα σταγονίδια που σχηματίζονται διαλύουν τους όξινους ρύπους και κάτω από την όξινη προσβολή διαλύεται η τεχνητή πατίνα και δημιουργείται ένα ίχνος σαν να έχουμε ροή νερού.

Διαδικασία συντήρησης:

- *Ο καθαρισμός ξεκίνησε από πάνω προς τα κάτω με διαδοχικές εκπλύσεις, αρχικά με νερό ύδρευσης και στη συνέχεια με απιονισμένο νερό για την απομάκρυνση των διαλυτών επικαθίσεων (π.χ. διαλυτά άλατα) και με μαλακή βούρτσα. Για τις λιπαρές επικαθίσεις προστέθηκαν σταγόνες μη ιοντικού απορρυπαντικού Texapon. **Κατά τη διάρκεια του καθαρισμού γινόταν συλλογή δείγματος** εκπλυμάτων και μέτρηση του **pH και της ειδικής ηλεκτρικής αγωγιμότητας, για να διαπιστωθεί η απομάκρυνση όξινων ή αλκαλικών** επικαθίσεων και διαφόρων διαλυτών αλάτων.*
- *Για την απομάκρυνση της μαύρης κρούστας, διαδικασία αρκετά χρονοβόρα και επίπονη, χρησιμοποιήθηκαν ειδικά σκευάσματα από προσροφητική άργιλο (σεπιολίτη) με απιονισμένο νερό και συμπλοκοποιητές ιόντων ασβεστίου (E.D.T.A.). **Το υλικό τοποθετούνταν** επιλεκτικά και σταδιακά σε μικρές επιφάνειες, για να μην έλθει σε επαφή με το μέταλλο και αφηνόταν να στεγνώσει επί μία ώρα. Έτσι αποδιοργανωνόταν η μαύρη κρούστα και η αφαίρεση γινόταν με νυστέρι. Ακολουθούσε καλή πλύση με απιονισμένο νερό.*
- *Αφαίρεση του διαβρωμένου στρώματος του παλαιού κεριού με μαλακό πανί εμποτισμένο με μίγματα οργανικών διαλυτών (αιθανόλη,*

ακετόνη και white spirit). Η εργασία αυτή ήταν πολύ επίπονη και χρονοβόρα γιατί το γηρασμένο κερί δεν διαλύεται εύκολα σε διαλύτες.

- *Μηχανικός καθαρισμός με υαλόβουρτσα για την απομάκρυνση των προϊόντων διάβρωσης και των επικαθίσεων στα σημεία ροής.*
- *Επαναδημιουργία πατίνας τοπικά στα σημεία που χρειαζόταν με διάλυμα θειούχου καλίου (K_2S) σε νερό 5% κ.ό., με προθέρμανση του μετάλλου και σταθεροποίησή της με αναγωγική φλόγα.*
- *Στην τελική φάση εφαρμόστηκε προστατευτικό μικροκρυσταλλικό κερί υψηλού σημείου τήξης.*

Manufacturing techniques

A) description of the sculpture.

The bust of Lenin is located in front of the building of the Greek Communist Party in Perissos, a suburb of Athens. For the construction of this large sculpture (1,80x1,40x1,40m), the artist, M. Makris, used copper sheet 1,5mm thick. The different parts are made to the appropriate shape by beating and joined together by soldering. The distinctive blow marks due to the hammering of the metal sheet create a surface pattern that is essential to the aesthetic appearance of the work. The shape and formation of each part followed a detailed model made of gypsum. The rough brazed joins were purposely not smoothed, in order to accentuate the basic features of the head.

The attribution of the eyes is of great importance for the work of art. The iris is made of white, blue, red and brown murano glass. Fig. 1. The powdered glass was poured into a copper mould in the appropriate shape and heated to melting point. Then each iris was adapted to the eyes of the sculpture.

The reddish brown colour of the sculpture is due to the original patina created through the use of potassium sulphide (K_2S) solution. Different shades of the patina, which were achieved by using solutions of different concentrations, pronounce specific features of the head (eyes, chin and neck).

B) the armature of the monument.

The bust stands on a prismatic base 1,5x1m and 4m high, made of concrete and covered by a greyish blue acrylic paint. The armature of the sculpture is made of steel beams, which are attached to a central steel pipe 15cm in diameter and 5mm thick. Each beam was fixed to the internal surface of the copper sheets during their placement. Polyurethane foam was used as sealant against percolating moisture.

Condition report

The original appearance of the monument has been significantly altered after 15 years of exposure to the intensely corrosive environment of Athens. Data on the environmental contusions of Athens are given by P.E.R.P.A.. A thin layer of dust and other particles deposited from the surrounding environment covers the surface.

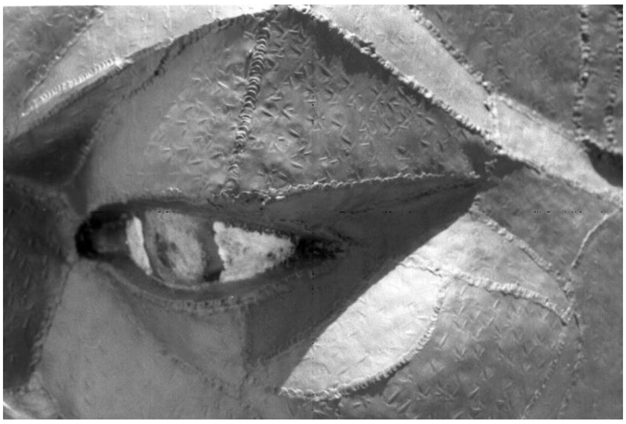

Fig. 1, The different parts are made to the appropriate shape by beating and joined together by soldering.

A) loss of the protective layer

A thorough observation of the sculpture revealed the localised loss of the artificial patina, mainly on the edges and the most exposed areas. The protective coating had lost its original transparency and in specific areas has a dull to whitish appearance (Fig. 4). Where the surface is protected from rainfall, it is coloured dark brown Fig. 5.

The alteration of the visual and mechanical properties of the organic coating is probably due to deterioration processes caused by the effects of oxygen/ozone, moisture, ultraviolet light and air pollutants. The main cause of the whitish appearance is the adsorption of aerosol particles from the polluted environment. In the dark brown areas, particulate matter has accumulated (e.g. soot, soil material), which is not washed away from the surface by rainwater. Besides the important aesthetic problems this causes, the degradation of the coating can dramatically increase the corrosion rate of the underlying metal.

B) streaking

The most evident symptom of time on the sculpture is the presence of whitish "streaking", mainly on areas that are not directly exposed to rainfall, but also in places washed by rain, such as the eyelids, the neck and the lowest part of the nose. This streaking consist of a rather hard whitish or grey substance, with a slight green hue. During the cleaning of this substance it was found that no protective coating or artificial patina was left underneath the streaking, and a bright copper surface was revealed.

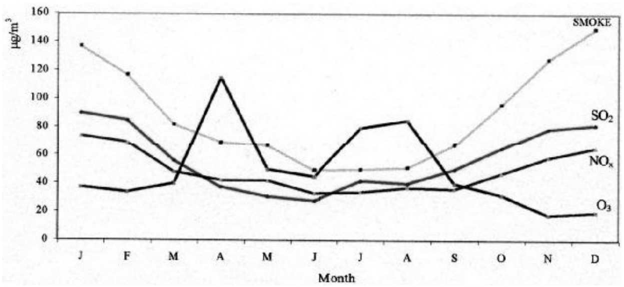

Fig. 2: development of atmospheric pollution of Athens - Patision station (1988-1997).
(mean values of the ten year period)

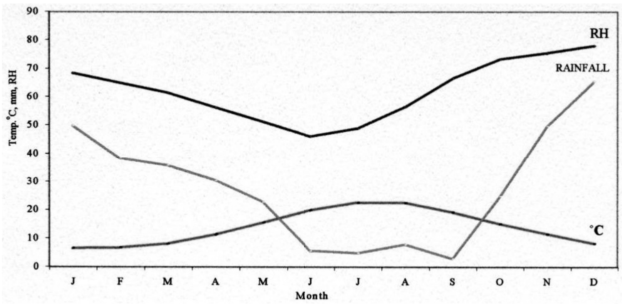

Fig. 3: development of climatic parameters of Athens - Patision station 1988 - 1997.
(mean values of the ten year period)

Fig. 4: Dull / whitish appearance.

In order to determine the composition and origin of this substance, a sample taken from the streaking was examined under a scanning electron microscope equipped with an energy dispersive X- ray analysis system (S.E.M./ E.D.X.A.).

The analysis of the substance, showed that calcium-containing material, probably of atmospheric origin, predominates within the makeup of the crust. Considerable amounts of silicon, copper, magnesium, aluminum and

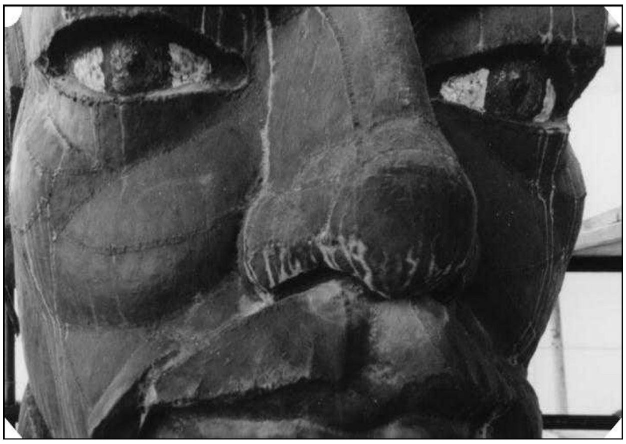

Fig. 5: Dark crusts on areas protected from rainfall.

potassium were also present. Iron and zinc were detected in small quantities. According to the analytical data and relevant references in the literature, the streaking material probably consists of salts that originate from various particles (e.g. soil material). The streak begins in places where a preferential condensation of water vapour occurs when ambient temperature reaches the dew point. In these water droplets acid pollutants, suspended particles and other corrosive materials are accumulated. All these materials can contribute to the attack on the artificial or natural patina or even the underlying copper metal through two main processes:

a. Direct contact of corrosive substances present in the various deposits (e.g. sulfur oxides, organic acids).
b. Withholding humidity on these specific areas of the sculpture.

These corrosive effects are responsible for the etching of the copper along the streaking. The detection of copper in the streaking material probably originate from copper corrosion products, which also give the observed characteristic green tint.

C) copper corrosion products

Layers of green copper corrosion products were observed on specific areas of the sculpture, especially around the brazed joins. From a well protected point on the neck of the sculpture we were able to take a sample of the corrosion products which was then observed under an optical microscope. The different corrosion products were identified by x ray diffraction carried out at the Demokritos laboratories.

As shown in Fig. 9, copper is covered by a continuous thin layer of cuprite (Cu_2O), followed by a thick green layer of paratacamite ($Cu (OH)_3 Cl$). The local formation of paratacamite on the surface can be explained by the attack of chlorides on areas where the coating had been removed or was loosely adhered

In the samples examined, there is no evidence of pitting beneath the layer of cuprite. However, the formation of paratacamite instead of other corrosion products usual on outdoor copper sculptures (e.g. copper sulphates) indicates the high concentration of chlorides in the surrounding environment, probably from the sea. The potential for a more severe attack in the future should be given serious consideration, as shown in previous work done by Organ (1970), Sharkey *et al* (1971) and Elwyn *et al* (1996).

D) iron corrosion products

Powdery orange-brown layers were observed around the joints of copper sheet and the steel armature. They probably consist of iron hydroxyoxides (Fe2O3.H2O, FeO (OH)) released through the cracks of the brazed joins. The direct contact between iron and copper probably leads to the galvanic corrosion of the steel beams (Fig. 12).

E) cracks on brazed joins

Several cracks and small holes along the welding revealed the presence of polyurethane foam in the internal space of the sculpture. Through these cracks and holes, water and other corrosive impurities can reach the internal surface which cannot be protected.

Conservation plan

Taking into account the above observations and results we can draw out our conservation plan.

The selection of the appropriate conservation method and materials was based on international ethical considerations for the maintenance of the outdoor metal sculptures and on the recent experience from relevant conservation work in Athens by Argyropoulos et al (in press) and Lins (1983) in USA.

1. Surface washing using tap water at a pressure of 2 - 3 kpa/cm^2. Washing finishes with deionized water.
2. Mechanical removal of the disfiguring corrosion products using mild abrasive techniques (glass-bristle brush) and hand tools (dental drill, scalpel).
3. Cleaning of the surface using a neutral detergent, deionized water and soft brushes, followed by the monitoring of the pH and the conductivity of the rinsing.
4. Local application of cleaning poultices for the removal of black crust.
5. Removal of any chemical cleanser or by-products by washing the surface with deionized water and measurement of the pH and the conductivity of the rinsing.
6. The removal of the old deteriorated protective coating using a combination of organic solvents.

fig. 6:"Streaking" on the surface of the monument.

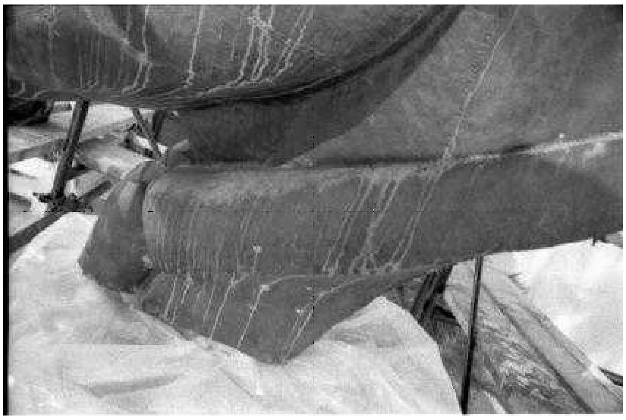

Fig. 7: "streaking" on sculpture.

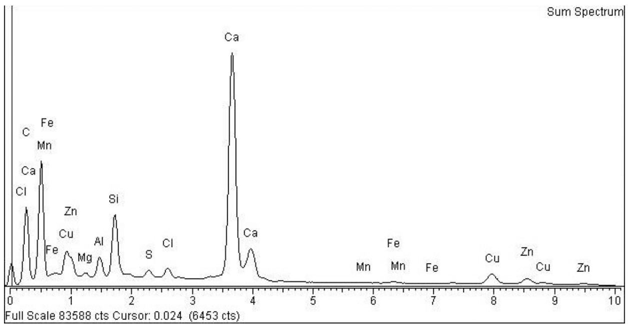

Fig. 8: EPMA analysis from the "streaking" shows the presence of suspended particles (calcium, aluminium and silicon compounds) with some corrosion products of the metal.

7. Repatination of the cleaned surfaces using 5% w/v solution of potassium sulphide in deionized water.
8. Final washing with deionized water, monitoring the pH and the conductivity of the rinsing.
9. De-greasing of the surface by gentle scrubbing with a soft cloth impregnated with acetone.
10. Protection of the metal surface by applying microcrystalline synthetic wax.

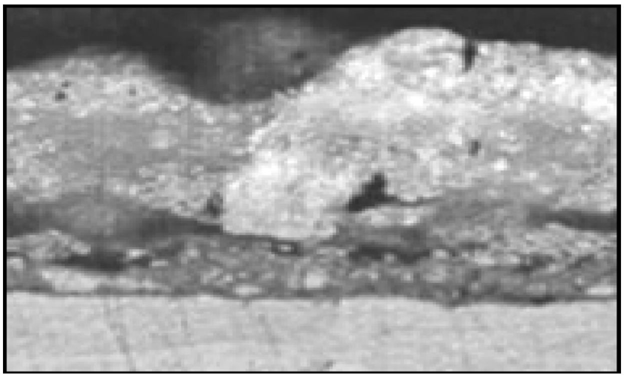

Fig. 9: Photomicrograph of the corrosion products, showing the successive layers of cuprite and paratacamite. A thin cuprite layer in contact with copper and a thicker paratacamite layer on top.

Fig. 10: Layer of green corrosion products.

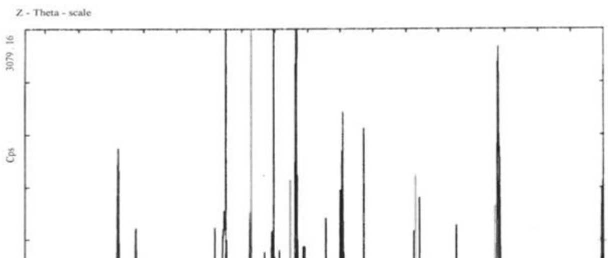

Fig. 11: Results of analysis by XRD from the points of fig 9, 10.

Fig. 12: Example of galvanic corrosion on welds.

Conservation treatment

Methods and materials

Conservation procedure

For the implementation of the conservation work, scaffolding was placed a round the monument Fig. 13.

- Cleaning tests were carried out on selected areas of the sculpture, in order to determine the effectiveness of each method and the time required for the removal of the various deposits and the dark brown crusts.
- The cleaning was started from the uppermost surface by rinsing with tap water and subsequently, deionized water followed by gentle brushing. In this way, most of the soluble or loosely adhered deposits were washed away from the surface. A non-ionic detergent (texapone) was used for the removal of grease. During cleaning the occurrence of soluble salts or any acidic or alkaline substances was observed by the measurement of the pH and the conductivity of rinsing samples.
- The application of sepiolite poultices with deionized water and the chelating agent E.D.T.A. removed the dark brown crusts. This time consuming procedure was carried out repeatedly and locally on the crusts, with special attention given to avoid contacting the metal with the poultice. The areas were pre-wetted and the poultice was applied and left to dry for about one hour. The repeated application of the poultices led to the collapse of the crusts, which were finally removed with the use of a scalpel. After treatment, the area was thoroughly washed with deionized water, as any residues could cause salt crystallization problems.
- The removal of the old coating with a soft cloth impregnated with a mixture of organic solvents (ethanol, acetone and white spirit), a time consuming treatment due to the insolubility of the deteriorated wax.
- Repatination of the bright areas of copper which had necessarily been revealed during cleaning (e.g. along the streakings) with the application of a 5% w/v potassium sulphide solution in deionized water, after pre-heating and using reducing flame afterwards.

Fig. 13. The monument with the scaffolding placed for the implementation of the conservation work.

Fig. 14: Front view after conservation.

Fig. 15: Side view after conservation.

Protection

For the protection of the monument against the rough outdoor environment, microcrystalline synthetic wax applied by heating the external metal surface to around 100 °C. The wax coating also toned down the variations in colour, and gave the surface a darker appearance than before, as was the artist's original intention. After the application by brush, a thin cohesive film is created, which is impermeable to water and resistant against acidic, alkaline or other corrosive substances. It is stable in temperatures up to 90°C and can easily be removed using the appropriate organic solvents.

Future Danger

The contact of the internal surface of the sculpture with polyurethane[10, 11,12,] foam can enhance the corrosion, as indicated by the research work of Proctor (1987), Oertel (1993) and Seinfeld (1986), via two processes: The first is related to the ability of this highly porous material to absorb and accumulate water and subsequently, pollutants, a serious problem for an outdoor metal sculpture exposed to rainfall. The second is related to by-products released from the degraded foam (such as nitrogen oxides, acrolein and hydrogen cyanide), which can directly attack the internal metal.

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