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Extended Abstract

Elemental and Corrosion Investigations Performed on Coins from 20th Century †

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Corrosion represents the transformation process of metallic surfaces, caused by the influence of the contact medium. Coins are not exempt from the undesired effect of corrosion. This process progressively alters their aspect, shape, and resistance until their numismatic and historical value is lost. Coins that commonly contain non-noble metals like iron are more susceptible to corrosion. Thus, modern coins undergo an electroplating process with more corrosion-resistant metals [1]. The aims of this study are to identify the elemental composition of coins from the 20th century and to submit them to an artificial electrochemical corrosion process.

The elemental composition of samples was analyzed by wavelength-dispersive X-ray fluorescence spectrometry (WDXRF) with a Supermini200-Rigaku Benchtop (elements ranging from ^{8}O to ^{92}U). Detection limit: 1 ppm–10 ppb; accuracy < 0.1–0.5%. The artificial rate of corrosion was electrochemically analyzed by the Tafel extrapolarization technique. For this process, a Voltalab PGZ 100 was used with an electrochemical cell consisting of three electrodes (the coin as the working electrode, Ag/AgCl as the reference electrode, and an auxiliary Pt electrode).

Results: X-ray fluorescence spectroscopy results for the 1966 M1 coin (Figure 1) revealed that the major chemical elements found were nickel (88.9%), followed by iron (2.88%). The usual corrosive chemical elements, like sulfur (0.38%) and chlorine (0.32%), were minor elements, indicating good anticorrosive protection of the electroplated layer. Electrochemical corrosion rate results for the same sample revealed a corrosion speed value of 1.55 µm/year (Figure 2).

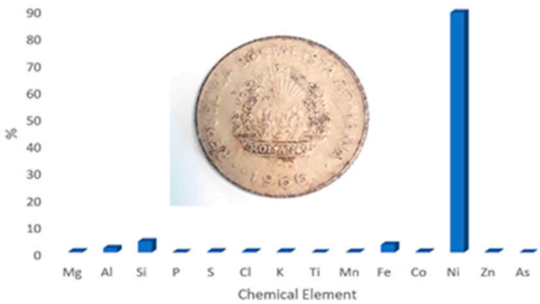

Figure 1. Elemental analysis of the coin.

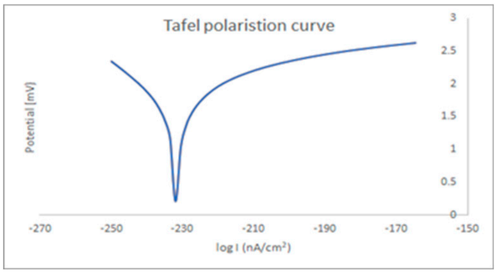

Figure 2. Tafel polarization curve of the coin.

Fluorescence spectroscopy is a non-destructive and sensitive technique for studying the elemental composition of coins, revealing all the metallic chemical elements used in the production of coins, and other chemical elements that can cause irreversible negative effects on coins. Electrochemical corrosion provides relevant information about the corrosion speed of metals in an electrically conductive medium.

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References

1. Abdulnaser, A.-Z.; Ghoniem, M. A characterization of coins from the najran hoard, saudi arabia, prior to conservation. *Int. J. Conserv. Sci.* **2012**, *3*, 143–152.