Mechanism of 'in situ' Gold Crystallisation

Michael Spiro

Department of Chemistry, Imperial College of Science and Technology,
London, SW7 2AY, United Kingdom

Electroless plating is suggested as a mechanism for the deposition of the small gold particles found on the surface of the Parker Gold Piece
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The evidence recently published by Albanese (1) on the deposition of small gold particles on a 1908 gold coin found in a sluice box suggests a mechanism of electroless plating. By this mechanism, metallic gold is formed from the reaction between dissolved (and complexed) gold ions and a dissolved reducing agent, probably organic in nature.

Although homogeneous reactions of this kind are usually slow, they are much faster at a metal surface where the electron transfer occurs by an electrochemical mechanism (2). The system can then be conveniently treated by the addition of two current-potential curves (3), that of the reduction of gold ions to metallic gold and that of the oxidation of the (organic) reductant. Since this process takes place at the gold surface, the deposition rate will increase as more gold is deposited. The reaction would have started on clean grease-free patches of the coin and continued on these, so explaining the localised deposits.

Electroless deposition of gold, especially in the electronics industry, is a well known technique (4, 5). The autocatalytic nature of such processes is well illustrated by the electroless deposition of the other group IB metals, silver and copper. Thus the development of photographic film depends upon the deposition of more silver on the tiny colloidal particles of metallic silver produced photolytically. These so-called latent images must be intensified 10⁸-10⁹ fold to yield a visible photographic image (6). Autocatalytic deposition is crucial here because uniform reduction of the silver ions in the film would only yield a fogged plate.

The autocatalytic nature of copper electroless deposi-

tion has also been visually demonstrated. An examination of old shipwrecked wooden vessels has revealed the presence of large grains of metallic copper (7), whose presence can be explained by the reduction of copper ions (from the corrosion of copper, brass and bronze articles in seawater) coupled with the oxidation of formaldehyde (produced by the slow degradation of cellulose in the wooden structure). The long time that had elapsed for these copper grains to appear is comparable with the half-century during which the gold particles formed on the 1908 Parker gold coin.

References

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