

ABSTRACT

Electroless deposition is one of the most versatile techniques for producing metallic and composite coatings without an external source of electrical current. Instead, electrons are provided through the oxidation of a reducing agent on a catalytic material. Some (typically metallic) substrates are themselves catalytic to the oxidation of the reducing agent but when electroless plating is employed on non-active materials such as polymeric substrates or textiles, initiation of the process cannot occur spontaneously as the substrate cannot oxidise the reducing agent. In this case, an additional activation step is employed, during which the surface of the substrate is decorated with (typically) palladium particles. Palladium (Pd) is the most extensively used catalyst for the electroless plating of non-active materials. However, Pd is very expensive and hazardous to the environment. Furthermore, this element is at a high supply risk in the next three decades and is considered a critical raw material (CRM). In addition, this activation method produces waste containing a noble metal.

In the present study, non-noble metals and compounds were employed as the initiator, and their potential as an alternative to Pd for the electroless process of non-active materials was examined. The concept of this research was to develop a novel mechanism and approach so non-noble metals can be employed as the initiator for electroless processes of copper (Cu), nickel-boron (NiB) and nickel-phosphorous (NiP). Therefore, the present research focussed on the following areas:

- Zn, Co, and Cu₂O were examined as initiators for electroless copper deposition onto polyester textiles. The effects of different activation step parameters, including initiator concentration, particle size, immersion time, temperature, and the particle dispersion method, on the final properties of the copper deposit were studied in detail, and the optimum conditions were obtained in the studied ranges of parameters.
- A uniform and adherent copper deposit was successfully obtained when Zn and Co were employed as the initiator for electroless copper deposition, closely matching the deposit properties obtained when a Pd-based catalyst was employed.
- It was elucidated that, for some non-noble metals, when used in particular electroless plating solutions, activation occurred via a displacement mechanism was developed and applied in the electroless process of polyester textiles to enable the use of non-noble metals as novel initiators for activating polyester substrates.

- It was demonstrated that Zn and Co could also be employed as alternative initiators to Pd in the electroless NiB and NiP of polyester textiles although the initiation mechanism, for Co, varied from that found when using electroless copper.

The present work proved that non-noble metals can be successfully utilised as alternative initiators for the electroless plating of non-active materials by both catalytic and displacement initiation. This knowledge widens the scope for non-noble metal initiation of non-active materials.