Alternative baths for the gold electrodeposition based on 1-butyl-1-methyl-pyrrolidinium dicyanamide ionic liquid

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Abstract

Ionic liquids (IL´s) are extremely promising solvents for the electrodeposition of different metals even though requiring working under dry and inert atmosphere conditions, which enables the extension of their electrochemical window and limits the oxidation of the deposited metals. With the discovery of air and water stable ionic liquids, their potential applications in electrodeposition has greatly increased. In this work 1-butyl-1-methyl-pyrrolidinium dicyanamide has been selected as an air and water stable electrolyte for the deposition of gold. The strong complexing capability of the dicyanamide anion is thought to induce high solubility of many metal chlorides, which together with the low viscosity of the IL´s are expected to improve mass transfer and conductivity, paramount properties for electrodeposition. Gold electrodeposition from 1-butyl-1-methyl-pyrrolidinium dicyanamide + 0.020 M $HAuCl_4.3H_2O$ solutions is examined under laboratory air conditions. Cyclic voltammetry, carried out on glassy carbon and nickel electrodes, suggested that gold species follow a sequential reduction, from $[AuCl_4]^-$ to $[AuCl_2]^-$ and $[AuCl_2]^-$ to Au(0), under diffusion control. Results are in agreement with those found with other ionic liquids under dry conditions [1,2]. Gold thin films were obtained on nickel and copper substrates under potentiostatic control at -1 V (Pt) at 20, 60 and 80 ºC and deposition times of 1500 and 4500s. XRD and TEM analyses on selected specimens showed that the electrodeposited gold thin films have a nanocrystalline structure. From the obtained current-time response complemented with SEM observations it is also verified that, within tested conditions, the deposition rate increases with temperature. Research continues in order to further investigate the effect of the IL water up-take on gold electrodeposition. The results so far achieved, indicate that nanostructured gold thin films are obtainable using 1-butyl-1-methyl-pyrrolidinium dicyanamide, without additives, when working in laboratory air conditions if a level of water concentration up to 1 wt% at 20ºC is maintained.

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References

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