

CHEMICAL GOLD-PLATING USING SODIUM BOROHYDRIDE AS REDUCING AGENT

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Electrolytes for chemical gold-plating with hypophosphite and hydrazine [1, 2], do not allow deposits to be obtained thicker than 0.3-0.5 μ . The use of alkali metal borohydrides [3-5] in place of sodium hypophosphite during chemical nickel-plating ensures a higher coefficient of utilization of the reducing agent and increases the hardness, wear resistance, and corrosion resistance of the coatings in consequence of the inclusion of boron in the deposits.

The electrolyte for chemical gold-plating which we investigated contains potassium dicyanoaurate, sodium borohydride manufactured by Soviet industry, alkali to prevent hydrolysis of the borohydride, and potassium cyanide.

The order in which the ingredients are introduced into the solution is very important. First of all the stabilizer (KCN) is added to the aqueous solution of the salt of the deposited metal; then the sodium boride, previously dissolved in alkali solution, is introduced. The solutions are mixed carefully and heated to the required temperature.

The optimum concentration in the electrolyte of potassium dicyanoaurate is 6 g/liter: in the 6 to 10 g/liter range the gold-deposition rate is unchanged and below 6 g/liter it falls sharply. When the borohydride concentration rises to 0.4 g/liter in the presence of 6.5 g/liter of KCN, the deposition rate increases and after this is almost unchanged. But, on the other hand, the stability of the solution diminishes and the temperature at which decomposition of the electrolyte sets in is lowered (Fig. 1). With the optimum sodium borohydride concentration of 0.4 g/liter the solution is stable even at 95-100°C, when deposition takes place at a rate of up to 3 μ /h.

When the borohydride concentration is 4 g/liter the electrolyte is already partially decomposed at 80° and up to 20% of the gold is precipitated after 10 min; but, when operated at a lower temperature the

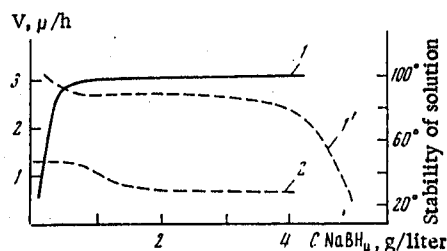


Fig. 1

Fig. 1. Dependence of gold-deposition rate (continuous line) and stability of solution at the given temperature (dashed lines) on sodium borohydride (NaBH₄) content. 1) KCN 6.5 g/liter, 2) without KCN.

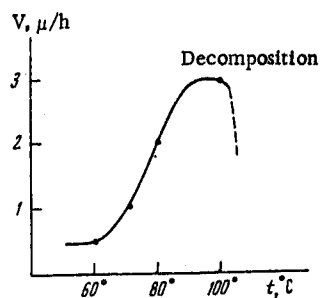


Fig. 2

Fig. 2. Gold-deposition rate as a function of temperature.

deposition rates are lower. The truth is that after filtering off the precipitated gold no further decomposition is observed even at 95-98°, and the deposition rate is quite high. However, such considerable gold losses in the preparation of the electrolyte are undesirable. This is possibly connected with the formation of less soluble sodium dicyanoaurate [6].

Hydrolysis of sodium borohydride in an aqueous medium [7] is only suppressed with $\text{pH} > 10$, hence the process does not take place at low pH. The gold deposition rate is at the maximum with a KOH content of 7 g/liter. Reducing this to 3 g/liter causes the solution to decompose but increasing it to 10 g/liter slows the process to a third of the rate. With a KOH concentration of 20-25 g/liter the solution is stable even without the stabilizer, but gold deposition ceases completely.

Similarly, the coating deposition rate also depends on the concentration of the potassium cyanide which is incorporated to prevent spontaneous decomposition of the bath. Its optimum concentration is 6-7 g/liter. With 13 g/liter deposition ceases completely. When the concentration is 3 g/liter spontaneous decomposition of the solution sets in.

Gold deposition commences at an appreciable rate of up to 1 μ/h only at 75°. With a further temperature rise of 10° the rate is almost doubled (Fig. 2) and at 95-98° the maximum rate is reached.

In all processes for the chemical deposition of metals a reduction in the deposition rate is observed when the concentration of the principal ingredients in the solution is reduced. In this connection a research was carried out on the increase in the efficiency of the solution when quite a high metal-deposition rate was maintained.

As would be expected, at 90° the solution has to be adjusted for potassium cyanide.

Adjustment for gold does not give good results. The decomposition rate of sodium borohydride in the solution referred to is very low. The solution is efficient until its gold has been considerably depleted.

Gold is deposited on nickel and copper substrates. The deposition rate is higher on nickel than on copper. Scarcely any deposition is noticed on palladium.

As a result of the investigations made the following optimum composition is proposed for a chemical gold-plating solution, which gives smooth deposits which adhere well to the substratum (g/liter): $\text{KAu}(\text{CN})_2$ —6, NaBH_4 —0.4, KOH—7, KCN—6.5, temperature 95-98°. The solution gives a deposition rate of 2-3 μ/h and enables coatings to be obtained with thicknesses up to 7-10 μ .

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