MECHANOCHEMICAL SYNTHESIS OF HIGHDISPERSED COPPER POWDERS

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Ultra-disperse metal powders are used in the formation of materials with increased porosity (battery electrodes, fuel cells, filters and adsorbents), with a fine-grained structure, with increased mechanical properties; when modifying the properties of polymer matrices (increase in strength, wear resistance, microhardness), the growth of films with a small grain size, the creation of 3D printer pastes, as components of solid phase synthesis, for highly disperse systems with a liquid medium.

The reactions of reducing copper oxides or metal salts with magnesium are highly exothermic [1]. Thesis investigation is devoted to mechanochemical synthesis of ultradisperse copper powders by the reduction of their oxides by magnesium, with the separation obtained copper powders from mechanocomposites.

In the process of mechanical activation of solid mixtures, simultaneously with the grinding of substances, an increase of the contact surface, acceleration of mass transfer, and, as a consequence, the activation of their chemical (mechanochemical) interaction. Applied importance of the studies of mechanochemical reduction of metal oxides for the purpose of opening and processing a diverse number of mineral and technogenic raw materials is difficult to overestimate, since this method is quite environmentally friendly.

In the case of using as an active metal - magnesium, it is necessary to know the compounds that can form at different stages of the process of mechanical activation in copper oxide -magnesium systems. The mechanochemical reduction of copper (I and II) oxides by magnesium in order to obtain copper powders is associated with the search for optimal conditions for mechanical activation, ensuring the oxidation-reduction reaction proceeds with the formation of copper and separation of its copper from by-products [2], determination of their shape dimensions, and oxidation protection conditions. It should be noted that treatment with hydrochloric acid solution allows partial transfer of Cu2O into the solution in the presence of air oxygen, to form a highly soluble CuCl2.

To separate the finely dispersed copper powder from the reduction by-products (magnesium oxide, copper oxide (I)), two variants of acid treatment for 30 min are proposed: 1) 1M HCl (343 K); 2) 0.5 M H2SO4 (298 K) followed by washing with distilled water and acetone. However, copper is separated from Cu2O under standard conditions, when 1M hydrochloric acid is treated, or 0.5 M sulfuric acid, followed by water rinsing is not possible. In the presence of air oxygen, at temperatures of 298 and 343 K, on the diffractograms, except for the reflexes of copper, Cu2O reflexes are retained.

To remove the copper oxide (I) and stabilize the copper powder from oxidation after washing with water, additional treatment with a stabilizer solution, water and acetone was introduced. Diffractograms of ultradisperse copper powders after such treatment do not change when samples are stored under standard conditions for at least 3 months.

Mechanochemical reduction of copper (I and II) oxides by magnesium was studied by X-ray phase analysis, electron microscopy, and element analysis of energy-dispersive x-ray spectroscopy. The conditions for separation of copper particles from other products and copper protection from oxidation during storage are determined. The results of electron-microscopic investigations have shown that after separation from by-products and stabilize copper powders consist of aggregates of primary particles of almost spherical form with dimensions of about 100 nm, which are part of the secondary particles - aggregates of 0.2 to 2 microns. The method of energy-dispersive x-ray spectroscopy is shown that the powders Mg copper content does not exceed 2%.

References

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[2] *Raschman P., Fedoroĉková A.* “Study of inhibiting effect of acid concentration on the dissolution rate of magnesium oxide during the leaching of dead-burned magnesite” Hydrometallurgy, (2004). V. 71, P. 403-412.

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