# STUDY ON THE OPTIMAL TECHNOLOGICAL PARAMETERS OF LEACHING OF METAL COPPER FROM POLYMETALLIC CONCENTRATE

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This research is urgent today due to increased worldwide interest in ecological friendly recycling techniques of polymetallic concentrates. Specifically, that refers to recycling of electronic waste with a focus on recovery of precious and rare metals in a pure form. Existent technologies of metals extraction imply chemical treatment with strong acids (e.g. hydrofluoric acid or aqua regia [1]) and non-recyclable chemicals; therefore, a problem of neutralization of liquid and/or gaseous acidic waste arises.

For reduction of the mentioned negative effect, copper leaching from the preliminary grinded and gravity separated polymetallic concentrate is justified due to economic and technological reasons.

As described in [2], copper-ammonia complex of $Cu[(NH_3)_4](OH)_2$ in alkali media has selective leaching properties in relation to metal Cu when extracted from polymetallic mixtures. Transformation of Cu from solid into the soluble form under the influence of the leaching complex proceeds in terms of the following equations (1, 2):

$$Cu[(NH_3)_4](OH)_{2(liq.)} + Cu_{(sol.)} \rightarrow \rightarrow Cu[(NH_3)_2]OH_{(liq.)} \quad (1)$$

$$4Cu[(NH_3)_2]OH_{(liq.)} + 8NH_3 + 2H_2O + O_2 \rightarrow \rightarrow 4Cu[(NH_3)_4](OH)_{2(liq.)} \quad (2)$$

However, it appears from the literature review that data on the optimal process conditions are very limited. Concentration of metal copper in the complex recommended in the literature falls inside the wide limits of 20–40 g. per liter. In this regard, the authors have studied the influence of concentration of the complex, temperature, solid-liquid ratio and reaction time on the leaching rate of metal copper. The following patterns were revealed:

1. Temperature regime at the range of 25–50 ° does not have a significant accelerating impact on the reaction rate (see Figure 1); therefore, it was decided to perform a leaching process at the room temperature due to technological reasons.
2. Concentration of metal copper in the complex and reaction time are the most important factors, which influence the rate of copper leaching from solid into the liquid form.

Then, it was found that longstanding single-stage leaching is inefficient due to formation of viscous sediment of metals hydroxides, which sig-

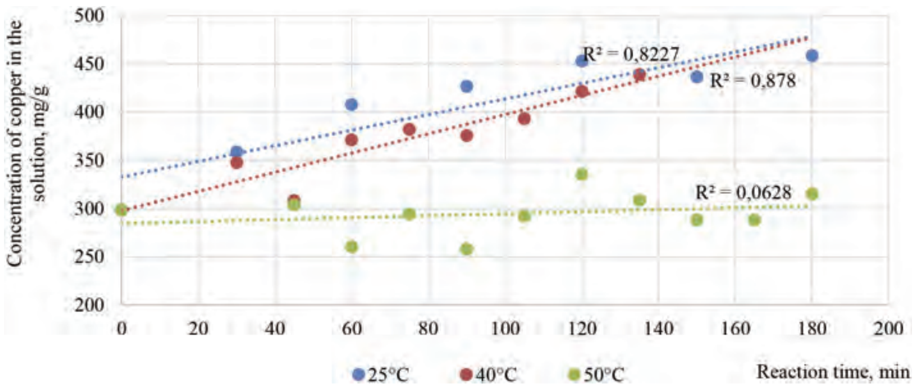


**Fig. 1.** *Leaching of copper at different temperatures*

**Table 1.**

| Stage # | Reaction time, min. | Concentration of copper in solid phase after leaching, mg/g. |
|---|---|---|
| 1 | 60 | 260.6 |
| 2 | 180 | 75.2 |
| 3 | 600 | 3.7 |

nificantly decreases the efficiency of leaching as a result of diffusion problems in sediment layer at the bottom of reaction vessel.

Thus, in order to achieve the maximum leaching rate of copper, the multi-stage process of copper leaching is proposed. Currently, it consists of three stages with arising reaction time on each stage (60, 180 and 600 minutes, respectively).

Results of three-stage leaching are provided in Table 1. Concentration of metal copper in $Cu[(NH_3)_4](OH)_2$ solution is 30 g. per liter, initial concentration of copper in polymetallic concentrate is 350 mg/g, reaction temperature is 25 °C, solid-liquid ratio is 1 : 10.

As it seen from Table 1, it was able to transform about 99.2% of initial amount of copper after three stages of leaching.

### References

1. *A. Tsamis, M. Coyne, Recovery of Rare Earths from Electronic wastes: An opportunity for High-Tech SMEs, Centre for Strategy and Evaluation Services LLP, 2015.*
2. *A. Chernyak. Chemical ore benefication.– M: Nedra, 1987 (224 p.).*

# INFLUENCE OF DISPERSION OF INITIAL MIXTURE ON ALUMINUM OXYNITRIDE YIELD

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AlON (γ-aluminum oxynitride) is a hard transparent ceramic material. Like many other ceramics, it has a good thermal and chemical stability. Previous studies have indicated that the AlON is stable between 60 and 73 mol % of $Al_2O_3$ for all temperatures between 1750 °C and 2000 °C [1].

Amorphous aluminum oxynitride (AlON) possesses unique properties of high dielectric strength, high resistivity, low loss, high decomposition temperature, chemical inertness, and high thermal conductivity. The main aim of the current research is to study the influence of dispersion of the initial mixture on the yield of AlON. In view of the interesting optical, chemical and mechanical properties, aluminum oxynitride spinel (AlON) has potential application as a high-performance structural ceramics and advanced refractory. In addition, it has been processed into fully dense transparent material, and it shows promising mechanical and optical properties suitable to use in infrared and visible window applications

One of the main conditions for a more complete synthesis of the process is the achievement of the maximum possible contact area between the particles of raw materials [2]. To achieve the full density of arrangement, we used alumina micron powder with aluminum nitride nanopowder (composition 1). To compare the effectiveness of micro- and nano-sized powder a mixture of powders of micron aluminum oxide and nitride was composed (composition 2). Processing of optically transparent AlON is more difficult than the synthesis of opaque single phase AlON, because the material must be fully dense, pure, and free of any secondary phases. There are several methods of getting transparent ceramics: simple reaction of $Al_2O_3$ and AlN, carbothermal reduction of $Al_2O_3$, plasma arc synthesis, and self-propagating high-temperature synthesis (SHS) [3]. In our investigation we used the first method, which consisting of some characteristic stages, such as: mixing powders, drying the powder, filling a mold, sintering the blank at high temperature for an extended time.

In this research $Al_2O_3$ Almatis (made in Germany) was used, which presenting white powder with a bulk density of 0.996 gm/cc. The second major component aluminum nitride AlN various dispersion was used. Pour density AlN-nano was 0.142 gm/cc and 0.776 AlN-micro gm/cc.

To study the synthesis of oxynitride phase tablets with a diameter of 30 mm and a height of 3–4 mm were molded, we used compacting pressure of 7 tons. Polyvinyl butyral is used as the binder component in an amount providing sufficient strength of the molded tablets. The first firing was carried out at 1750 and 1850 °C temperature and held at max-