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EFFECT OF DEFORMATION DEGREE ON WIDENING OF GOLD WIRE

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ABSTRACT
Investigations were done at round gold wires of 0,9 mm in diameter, used in jewelry making, from Au585 alloy (58,5%Au, Ag, Cu and Zn). These cold drawn wires was cold rolled in two rolling programmes to various heights without any intermediate annealing on a two-high rolling stand with plain rolls of 180 mm in diameter. In first programme, the wires were rolled in several passes, with single height reductions of about 30%, while in second one the rolling was carried out with maximal reduction only. Rolling speed was constant at all passes. It vas noted that more significant increase in widening, at samples rolled in a single pass, was at height reductions over 70%, while at samples rolled in several passes significant increase in widening took place at high reductions of 80% and over. Greater widening was obtained at rolling wires with maximal reduction only in comparison to wires rolled in several passes with small single reductions.
Keywords: gold wire, cold rolling, deformation, widening

1. INTRODUCTION
Gold has always been used the most for making jewellery. Mainly wires, strips, leaves, profiles are made from gold alloys by methods of plastic deformation of metals [1,2].
Round gold wire Au585 is processed by drawing and is very widely used in jewellery making and industry. Processing of this wire by cold rolling into flat profiles and strips is not used much. Researches carried out on copper show that stress distribution in deformation zone leads to local changes in deformation area [3-5]. Material flow in deformation zone, both longitudinally and transversely to the rolling direction, depends on many factors, so there are still no methods for certain determination of those quantities, especially widening, which affect quality of attained products significantly. For rolling of round dip-forming wire into strips, big non-uniformity of deformation in cross section and width of wire is typical. This non-uniformity leads to appearance of differences in structure and mechanical characteristics along the wire intersection, what can influence technological and exploitation properties.
Thin strips that are used for making gold jewellery are often obtained by cold rolling of round gold wire on plain rolls. The process of widening of rolled materials, which is still defined insufficiently, has significant influence on their quality.
Some formulas that are used for calculating widening at rolling rectangular profiles on plain rolls include length of zone deformation, sample's dimensions, friction coefficient, etc. However, all the formulas include height reduction what means widening is very dependent on this factor. Therefore these researches are subjected to influence of height reduction on widening at rolling round profiles.

2. EXPERIMENTAL

Au585 alloy (58,5% Au, 6% Ag, Cu, Zn) was prepared from Au – purity 99,95%, Ag – purity 99,99%, Cu – purity 99,95% and Zn – purity 99,96%. The alloy was melted in a high-frequency induction furnace into previously warmed moulds, and billets 18 x 20 mm in cross section were obtained. The billets were afterwards rolled on grooved rolls by square-square system to 1,5 x 1,5 mm, and after drawing the round wire of 0,9 mm in diameter was obtained. Process annealing were performed during rolling at billet's dimensions of 10,6 x 10,6 mm, 5 x 5 mm, 1,95 x 1,95 mm and 1,5 x 1,5 mm. The round wires obtained after drawing were annealed, as well. Two experiments were conducted. In first one, the wires were rolled in several passes, with single height reductions of about 30%, while in second one the rolling was carried out with maximal reduction only. Cold rolling of wire into strips was performed on a two-high rolling stand with plain rolls of 180 mm in diameter. Rolling speed was constant at all passes and lubrication conditions were equal. Schematic presentation of the experimental procedure is shown in Figure 1.

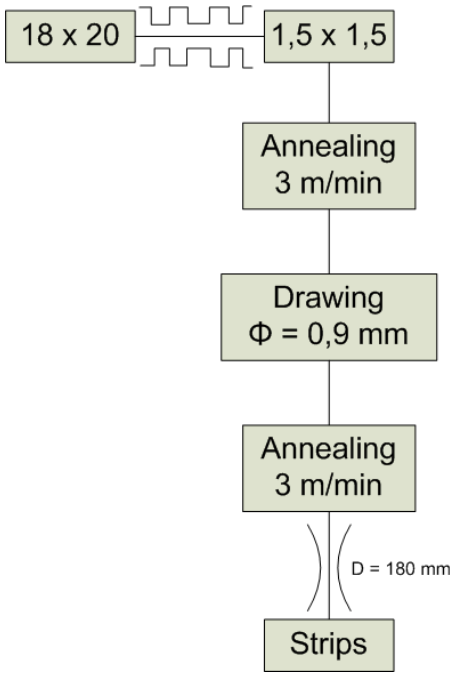

Figure 1. Schematic presentation of the experimental procedure

3. RESULTS AND DISCUSSION

Widening of samples made of Hamilton alloy depending on height reduction is given in Figure 2. Full line curve represents widening of round wire samples in function of height reduction after the first pass. Dashed line curves represent dependence of widening on height reduction in other passes, it is: for samples rolled with minimal reduction per pass – lower curve and after the maximal reduction in first pass – upper curve.

A general equation form for all curves is given as:

$$y = b \bullet e^{ax}$$

It was noted that more significant increase in widening, at samples rolled in a single pass, was at height reductions over 70%, while at samples rolled in several passes significant increase in widening took place at height reductions of 80% and over. The results also show that rolling of wires with maximal reduction in first pass resulted in greater widening in comparison to wires rolled with small single reductions per pass.

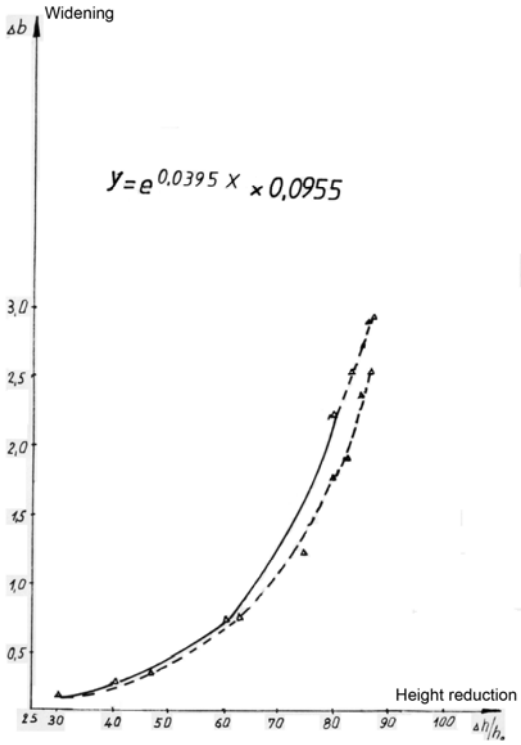

Figure 2. Dependence of widening on height reduction

With increase of zone deformation length longitudinal strain increases, i.e. resistance to metal flow in rolling direction so material widens, and that's why widening is greater with increase of height reduction. Because of that rolling of samples with a single maximum reduction results with greater widening.

4. CONCLUSIONS

1) Rolling of round gold wire of 0,9 mm in diameter, on plain rolls, results in very thin strips with smooth edges and no cracks.
2) Widening increases exponentially with increase of deformation degree and general equation for all the curves is given as $y = b \bullet e^{ax}$.
3) More significant increase in widening, at samples rolled in a single pass, was at height reductions over 70%, while at samples rolled in several passes significant increase in widening took place at height reductions of 80% and over.
4) Greater widening was obtained at rolling wires with maximal reduction only in comparison to wires rolled in several passes with small single reductions.

5. ACKNOWLEDGEMENT

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