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CHANGING IN GOLD JEWEL ALLOY QUALITY DURING GAS AND LASER WELDING

Abstract: *The gas welding technique is in application for gold jewel production over millenniums, while the laser technique only few decades. The comparisons of properties which were changed during gas or laser welding technique is applied, still are not fully defined.*

Here are discussed the most important demands from gold jewels: aesthetic appearance, min. gold content into alloy, mechanical properties, risk of damage, etc.

It is expected that nozzle diameter shows a remarkable influence on heat input during gas welding, and than many properties of gold alloy to be welded are undergoing to changing. Main properties which will be changed belong to an aesthetic group of properties (shining, polishing properties, etc.) and even failure of joined parts. During the gas welding the wide area of gold jewel is heated up, it means that most of properties of gold alloy also are changed, more precisely the quality is lowered.

The laser welding technique used in gold jewel production has shown less risk on failure in comparison to gas welding [1]. After the laser welding is provided, the clean surface remains unchanged.

Keywords: *gas & laser welding, quality, damage*

1. INTRODUCTION

Through the history, up to Industrial revolution, the noble metals mainly are used as jewels and less for coins. So, their quality is far away to be investigated. The quality of jewels is pretty specific according to other machine components: mechanical or wear properties should not be so high but they have not neglected. Through the human history and all over the world the golden jewels sustain, first of all by its quality and nobles. The production methods were the high secret, during millenniums: an extraction from ores, refining, melting, alloying and finally the making of (shining) jewels. To metallurgist and chemists is well known that for extraction and refining the gold the very reactive substances should be used. They may have an influence on the obtained quality of produced golden jewel. The structure and properties of golden jewels still are less known in comparison to steels and other common metals [1,2] from industry or daily life consumption.

In jewel making procedures, the welding and brazing of golden parts frequently are obvious. Heating up during welding/brazing may have lead to the

changing of important properties in jewel alloy [2,3]. The regime of cooling also may lead to the undesirable changes in jewel alloy quality. The most popular golden alloys in jewel making are 585 and 750 alloys, 14 and 18 karats alloys, respectively. The surface properties are of extremely importance for each jewel.

In named alloys the brittleness of such products sometimes is appeared. This is a main reason for quality decreasing of gold products. Generally, the brittleness in gold alloys is disproportionally less investigated than for example in steels or other structural/tool materials.

For understanding the production technologies, application of contemporary technologies, and quality insurance, it is not enough to say (as managers used): the optimal technology should be applied. The problem is really (and only) in the domain of technology [4]. The bad technology is able to exchange the design or surface properties of a jewel.

2. CASTING AND METAL WORKING PROCESSES

Melting and alloying of noble metals during centuries and millenniums have been practiced only in a manner of "black box" principle [5]. Now, from the market reasons the golden alloys for jewels or other purposes are obviously standardized, when the content of noble metal is strictly defined. It means that the content of noble metals is guaranteed, and it is a law for all producers of golden jewels. The casting processes now are improved, so an induction apparatus in connection with vacuum furnace can be found for melting & alloying purposes. Casting is provided in a variety of moulds, made from metal, gypsum, etc.

Most of noble metals, especially golden alloys, are deformable by using a great degree both of warm or cold reduction, i.e. almost of them posses a relatively good plasticity, but not every noble metal does. After providing a cold reduction, the grain size is undergoing to markedly changes, as illustrated in Figure 1.

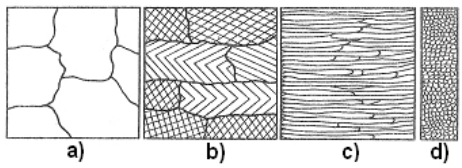

Figure 1 – Changing of crystal grain size in structure after cold deformation of sheet:
a) ε = 0%; b) ε ≈ 40%; c) ε ≈80÷90%; a,b and c)-longitudinal direction, e) transverse direction

a)

b)

Figure 2 – Casting of wax into silicon rubber a) of some finished parts b)

In gold jewel production cold deformations up to 70% are resonable. The changes, after applying cold deformation, may have lead to other difficulties in further production, here in jewel making. In gold jewel production from the working processes the most popular are rolling and drawing [6]. After application such working methods, the obtained semiproducts further should be joined, usualy by welding or brazing. All of listed metal working processes certainly have an influence on obtained qualiity of golden jewel. Castings or deformed parts made from noble metals are pretty small, indeed, as it was shown in Figure 2.

Products from Figure 2 or others, may posses different strength. The weak products easy will be deformed and this is an undesired property for all kinds of jewels.

3. CHARACTERISTICS OF GAS WELDING IN GOLD JEWEL PRODUCTION

Gas welding technique as a method in jewel production was known by the ancient people. In the past, gas welding is used for most types of joined structures. The gas welding in jewelry production still is a manual process. The advantages of gas welding/brazing are in great versatility in production of medium and large parts and in a low capital costs for equipment. Besides the filler rod, either for gas welding or brazing, the flux must be used, usualy they are boric acid (HBO_3) and sodiumtetraborate ($Na_2B_4O_7$) x $7H_2O$.
While the acethylene is the most common combustion gas for steel, for welding or brazing of noble metals is more popular propane-buthane gas mixture. This mixture is available for heating up the workpiece to the required temperature. The torch flame simply must be wide [8,9] and this is realy disdvantage for gas welding or brazing of small parts, especially in repairing works. The wide gas torch will produce remarkably change, it means reduce, the surface quality. Gas welded components should be cleaned from remains. The high heat input in gas welding/brazing sometimes causes severe deformations of the workpiece. Great heating also may have lead to undesired structural changes, fume products at the surface, even cracks in some noble alloys, etc. In jewel production of noble metals, the working parts are never large or massive. New processes have limited the area of gas welding/brazing application. The quality of gas welded joints usualy are not at the high level. After finishing the gas welding, the surface even at golden parts became discolored and full of cobmustion products and flux remains, which must be cleared.

Microstructures of weldments obtained in gas welding generally are well examined in steels (because this technology is the oldest one) while they are less known for noble metals [10]. In gas welding, nevertheless for joining of steel or noble metals, the heated area (including melting zone or HAZ) is pretty large.

4. CHARACTERISTICS OF LASER WELDING IN GOLD JEWEL PRODUCTION

Laser welding is one of methods available in noble metals fabrication. While the gas welding technique requires using a flux, usualy the filler metal, the laser technique does not [1,3,6]. Laser shots lasting for a milliseconds. This short time periods ensures that suroundings of the shot point are not affected by great heat input, i,e. the thermal treatment in the wide area [8÷10]. Leser beam usualy has not a deep penetration and this fact is used for decoration of polished surface. For example, Figure 3a), only a half of ring is treated while second half still is smooth

and shine. This is a realy an advantage in qualitative treating of jewels surface. Such decoration simply is not imposible to do by using a gas welding technique. For small parts, as golden jewels are, the narrow laser beam successfuly could be used for repairing works, Figure 3b), when the stone material must stay anchanged, i.e. not be exposed to heat. For the same task the gas welding practically is impossible to apply.Than, laser beam is very suitable for improving the quality of golden jewel quality.

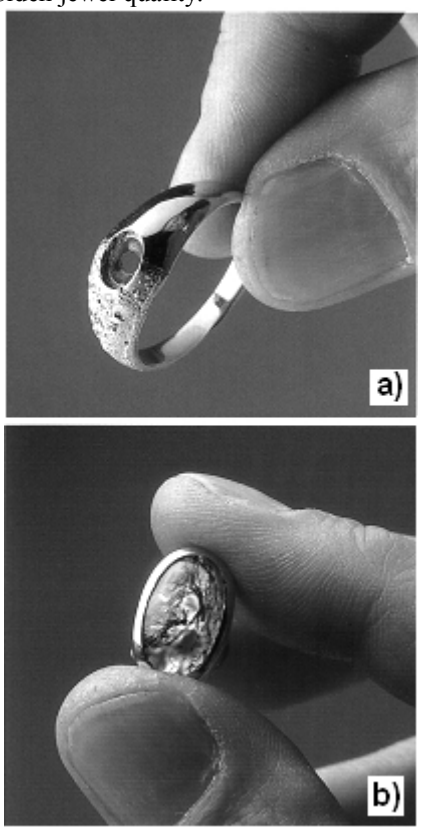

Figure 3 – Normal size of golden jewels after laser treating of: a) surface of ring and b) ring with stone

For a couple of secundes or minitues, the job either for welding or decorating of jewel is finished, without any furter technological operations.

5. DISCUSSION ABOUT CHANGING A GOLD ALLOY QUALITY DURING WELDING

The quality of gold jewels frequently is monitored through the price (it refers on a content of noble metal) and design properties (shining or similar). The quality of jewel also is referred on crack(s) appearance into used material. While the pure gold is an extremely plastic metal, some complex alloys were not. Some complex golden alloys are undergoing to crack appearance, as a result of applied production technology, it means from production stages as are: melting, casting, deformation, welding or brazing. One type of crack which is appeared in gold alloy 585 is shown in Figure 4. For gold alloys only the slow cooling may be a reason for appearance of such crack. From avoiding the cracking, fast cooling must be provided. The slow cooling may be released either after gas or laser welding is done. Such crack very soon may lead to the damage of golden jewel product. It is clear that damage will reduce the quality of any product, including the golden jewel.

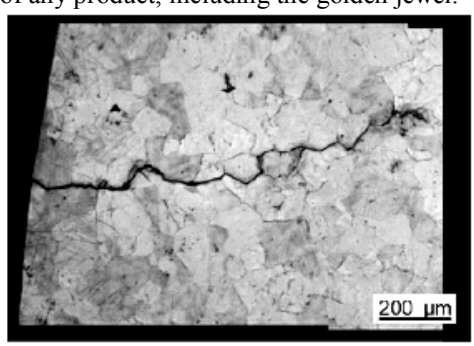

Figure 4 – One intercrystal crack in 585 gold jewel alloy

Either the intercrystal type of crack, in gold alloys may be present also transcrystal crack [2,9]. No one of them has not desired in golden jewels. Structural changes into an alloy are responsible for appearance of crack(s).

6. CONCLUSION

The pure gold is an extremely plastic metal while some complex alloys were not. On the total quality of golden jewel, the production schedule has decisive influence. The quality of gold jewel alloy is guaranteed by standard in the content of gold while other properties (strength, structure, etc.) or cracks are not a matter of standard regulates.

For obtaining a high quality of golden products, even a jewel, the smaller reductions have advantage or if heavy deformations are provided that intermediate annealing(s) are obvious.

An advantage of gas welding lies in simplicity of used equipment and low capital costs. The quality of such welded golden jewels is not on a high level, because after the job is done the large amounts of remains were stayed at the surface. Those remains must be carefully cleaned.

The laser welding is a faster method of joining than gas welding, and is possible to use when thin & complicated parts are produced. the narrow laser beam enables a welding of small parts, and if they contain a stone. Laser equipment still is expensive. It is evident that laser welded parts are pretty clean, they were not overheated in a wide zone as in gas welding. Further, the laser welding is available for coloring of golden jewels, which is impossible to do by using a gas welding technique.

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