COMPARATIVE RESEARCH ON THE QUALITY OF AUTOMOTIVE STATORS CONDUCTORS WELDING OBTAINED THROUGH BRAZING AND TIG WELDING METHODS

Сравнително изследване качеството на завареното съединение при електросъпротивително и електродъгово заваряване на статорите на електрогенератори

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Abstract:*The goal of the project is to compare the quality of automotive stators conductors welds produced by means of Brazing and TIG welding. As a result of the performed experiments and microstructural analysis of the welded joints, we have been able to prove the advantages of the brazing method over the TIG method.*

Keywords: CONDUCTORS, HYBRID STATORS, BASKET OF STATOR.

Introduction

It is well known that the quality of the welding process is of critical importance for the quality of the starters armatures and alternators stators. The goal of this research is to study the most popular welding methods applied in welding the stator conductors and the armature commutator.

The most popular welding methods applied for this purpose are the TIG and the brazing welding methods. The laser method has not been under consideration due to information from some users about serious doubt for danger to the operators' health. The TIG method is realised by using a very high temperature (the arc temperature reaches up to 10,000 °C) and an inert gas for protection, usually argon, needs to be used. The brazing method is realized by 720 °C and an additional material - a Sil-Fos band (85% Cu and 15% silver).

Experiments for conductors welding process

The goal of these experiments has been to study the welded joints of the conductors and to compare the resulting strength between the TIG method and the brazing method (copper-silver 15% band). The cooling during the brazing welding is carried out by water or by an air-powered "Vortex Tube cooler". The experiment was to study the strength of the welded seam by using destruction of the welded connection by a test machine. (See Fig.1-2)

- The tensile test results (table 1) have shown that the brazed joint is 30% stronger than the joint realized by TIG welding. The joint obtained by the brazing method is stronger than the base metal. This joint always tears away from the base metal directly to the welded joint. See Fig.3.

Reliability of the welded joint obtained by the brazing method

The metallographic analysis of the welded joint by employing brazing method has shown that it is solid and without pores or hot cracks. The welding layer is without cracks and inclusions. Please refer to Fig.4-5 for the metallographic photos.

Reliability of the welded joint obtained by the TIG method

For the analysis, the metallographic pictures of samples obtained by the TIG method have been studied under an electron microscope. (Fig.6-7).

The metallographic analysis of the TIG welded joint has shown:

- coarse crystal structure in the welding zone (Fig.8)
- non-metallic inclusions (Fig.9)

- the welding zone is not solid and has big pores. Please refer to Fig.9-10 for the metallographic photos.

Furthermore, the analysis of the obtained results shows that the TIG welding has many disadvantages compared to the brazing method. The most important are:

- TIG welding method - The high welding temperature makes the copper very aggressive and helps for the formation of pores in the welding area; in brazing method the welding temperature is 720 °C and such pores have not been found. This result explains why the strength of the brazed joint is almost two times stronger compared to TIG.
- TIG welding method – can easily go out of control, while the brazing method can be controlled very precisely.
- TIG welding method - a very expensive method, compared to the brazing method!
- TIG welding method – lack of consistency of the welded joints.
- TIG welding method - very difficult to repair wrong welds compared to the brazing method.
- TIG welding method – there is a safety concern; the high temperatures cause unhealthy emissions, thus are posing higher health risks! Also, it is bad for the environment.

We have made a comparison in the electro resistance of the stator conductors ends welding. The comparison is between two of the most popular welding methods: brazing and TIG. Please see below in the table 2 obtained results. All measurements of the electrical resistance have been made by a precision ohmmeter. The results of the experiments unambiguously indicate that the brazing process has less electrical resistance, respectively less electric and thermal losses. These measurements have been performed at room temperature, but it is known that the losses will increase with increasing the ambient temperature.

The gathered results unambiguously show the advantages of the brazing method compared to the TIG method.

Fig.1 *Destruction process of the samples on the test machine to determine the strength of the welded joint.*

Fig.2 *Recording the extension during the sample demolition for creating a stress-strain diagram.*

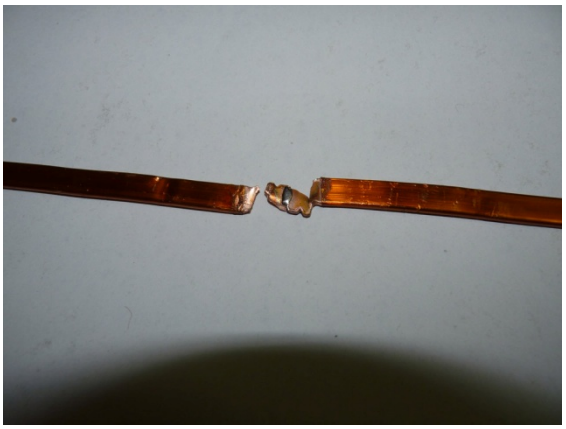

Fig.3 *The sample after tearing.*

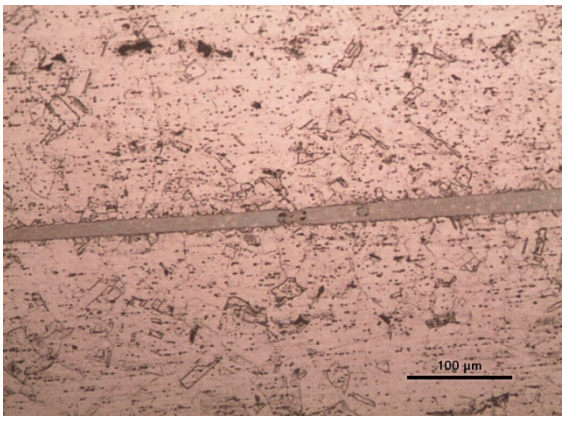

Fig.4 *Metallographic structure of welded joint*

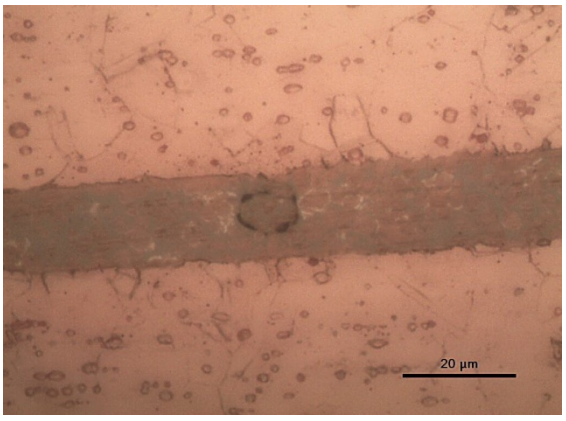

Fig.5 *Metallographic structure of welded joint*

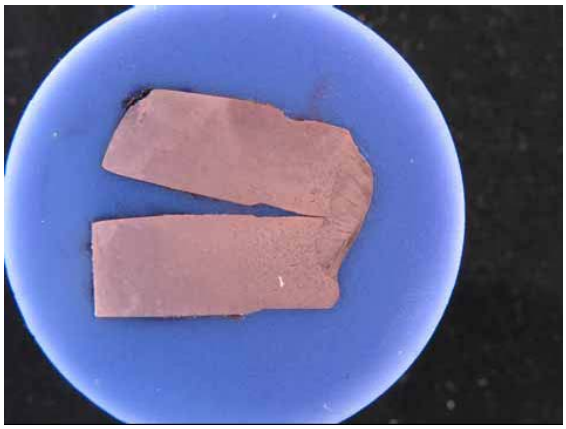

Fig.*6 Metallographic sample of weld obtained by TIG welding*

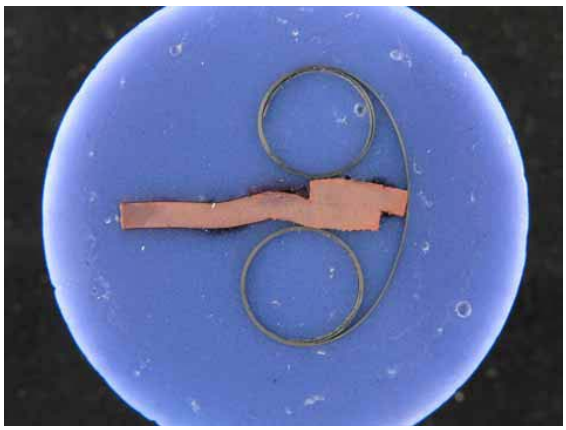

Fig.7 *Metallographic sample of welded joint obtained by brazing method*

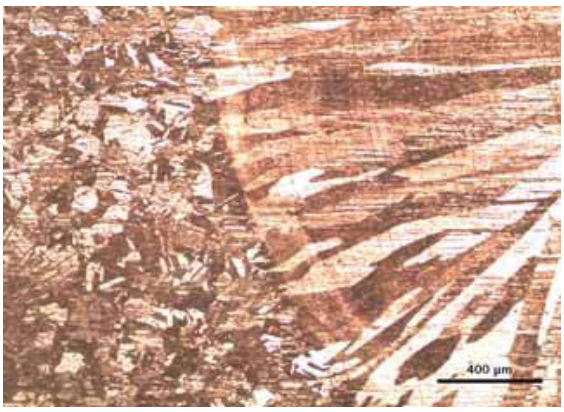

Fig.8 *Crystal structure in the welding area*

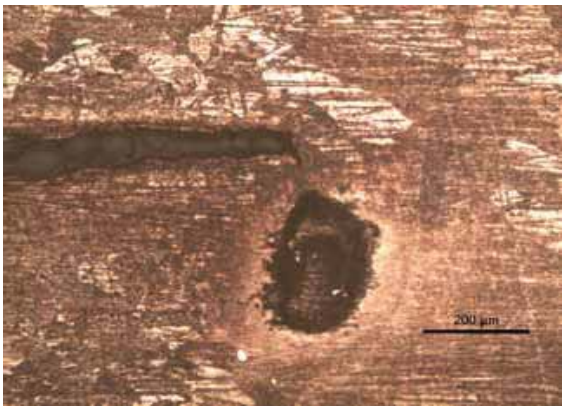

Fig.9 *Cracks in the welding area*

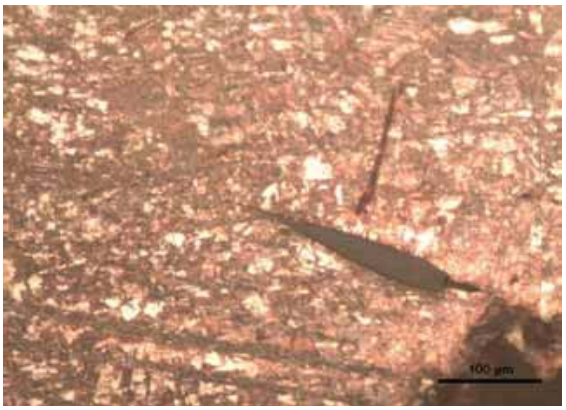

Fig.10 *Non-metallic inclusion in the area of welding*

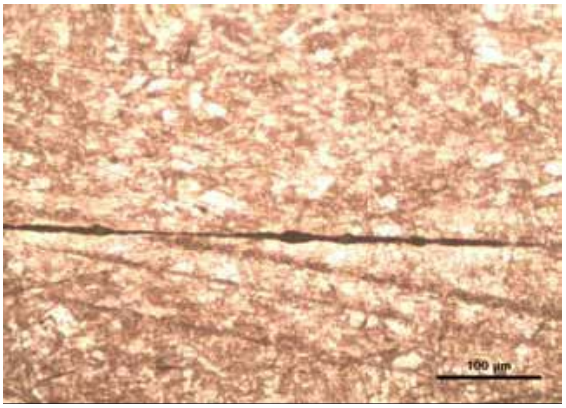

Fig.11 *The microstructure of TIG welding layer*

Table 1

TENSILE TEST OF WELDED JOINT	
BREAKING FORCE Pmax (daN)	
TIG WELDING	BRAZING
60	103

Table 2

Sample #		Brazed μΩ	TIG μΩ
1		102	117
2		105	114
3		100	116
4		97	114
5		102	114
6		105	113
7		98	116
8		99	117
9		98	112
10		102	115
11		106	117
12		99	113
13		102	115
14		106	117
15		107	115
16		99	112
Average		101,6875	114,8125
Range		10	5