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Influence of Welding Process on Microstructure & Mechanical Properties of Zinc Brasses: A Review

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Abstract- The friction stir welding (FSW) method was used to construct lap welded connections of copper and brass metals with different welding heat inputs. At two different joint configurations (Advancing and Retreating side), the microstructure and mechanical characteristics of overlap welded joints were studied to determine the effect of welding heat inputs on the microstructure and mechanical properties. Copper and brass plates are situated on the top and bottom plates, respectively, in both joint arrangements. The mechanical parameters of a dissimilar lap welded joint were evaluated using tensile-shear and vicker's microhardness tests. Optical microscope (OM) and scanning electron microscopy (SEM) were used to examine the microstructure and fracture surface of lap welded joints. Increasing the welding heat input resulted in the weld surface of the samples not showing any groove flaws, low unnecessary flash, or oxidation, according to the data. The weld nugget zone (WNZ) is defined by an onion ring pattern characterized by the stack of copper and brass metals. Strength in both tensile and shear was enhanced by reducing welding heat input. In both joint designs, the WNZ displayed the maximum toughness with increasing welding heat input.

Keywords- Friction Stir Welding; lap joint; Copper; Brass; Microstructure; Mechanical properties.

I. INTRODUCTION

Welding is one of the most cost-effective methods for permanently affixing two or more different materials together using heat and pressure. The interacting surfaces of the materials merge during welding, forming a continuous metallic connection.

To put it another way, welding is defined as the thermally induced, uniform joining of two or more surfaces. Due to the quick solidification of the weld zone, the hardness of a material can be affected by variables such as metallurgical changes and oxidation caused by the interaction of ambient oxygen with metals.There are a variety of welding procedures available for joining various materials, but they may be divided into two major categories: stick welding and TIG welding.

The metals are connected by heating them to a plastically deformed condition and then applying external pressure, such as resistance welding, to the work pieces.Arc welding is an example of fusion welding, in which the work piece metals are bonded by heating them to a molten state and allowing them to cool and solidify.

Welding process classification: Welding using Compressed Gas arc welding, thermo-chemical welding, and resistive welding. By employing Friction Stir Welding, developed by W. M. Thomas et al. of The Welding Institute (TWI) Ltd. in 1991, numerous issues connected with traditional welding processes were solved. It is possible to weld aluminum using FSW, a solid-state method that generates excellent welds. For the construction of light transport structures like trains, boats, and planes, it's becoming a superior alternative to fusion welding. Making goods that are lighter and stronger while using less energy, at a cheaper cost, and without utilizing environmentally hazardous materials is becoming increasingly difficult for fabricators. FSW is a low-energy, mechanically reproducible technology that may produce high-strength welds from a wide variety of materials at lower costs and with less impact on the environment than other methods.

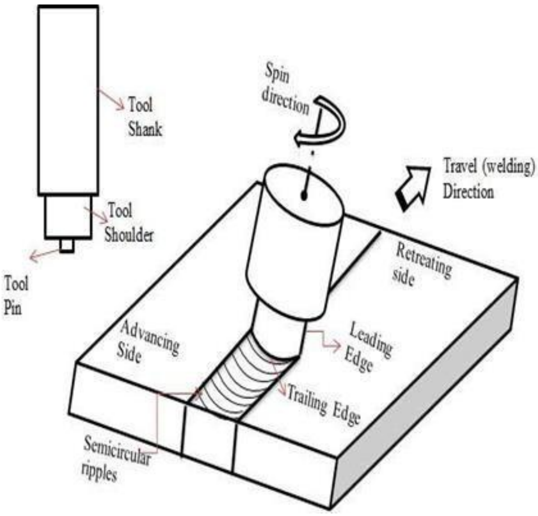

Fig 1. Principle of FSW for butt joints.

In FSW a cylindrical rotating tool having a concave shoulder with a profile pin/probe, is slowly inserted between two butted pieces along the joint line. The parts needed to be backed up by backing plates and properly clamped to withstand the welding forces. Frictional heat is created amid the tool and the work-piece material. Due to the heat generation the material gets softened and allows the movement of the tool pin alongside the joint line. The maximum temperature that can be grasped/reached is about 0.8 time the melting temperature of the parent material.

The plastically deformed material is transported from the front or leading edge to the back or trailing edge of tool pin and is forged by local contact of tool pin and its shoulder. A solid bond is left amid the two work-pieces. It can be compared to keyhole welding as a hole is generated to give path to the tool pin and later filling the hole in the course of the welding sequence.

The rest of the paper is organized as follows. Section II introduces previous work & achievement of previous researchers and III gives the details of experimental work & IV tell results analysis of the proposed welding are discussed in Section IV. The conclusions are given in Section V.

II. RELATED WORK

High zinc brass friction stir welding was explored by Afshin Emamikhah et al. (2013). The morphology of the material was evaluated by optical microscopy (OM) and scanning electron microscopy (SEM). Also,

Welding temperature was measured as a function of time. Temperature and micro hardness distribution, as well as microstructure consistency, were shown to be closely related, according to the findings. Researchers found no dezincification and emitted fumes during the experiment.

Copper and brass plates with a thickness of 3 mm were investigated by Mehmet Erdem (2014) at various rotating and welding rates. Reduced heat input improved microstrain and mechanical characteristics while revealing a SZ tunnel fault. The SZ has micro-hardness levels ranging from 87 HV to 255 HV.

FSW joints fabricated from 2219-T62 aluminum alloy were subjected to strain-controlled fatigue testing by W.F. Xu et al. (2014). As the welding speed was increased from 60 to 200 mm/min, the fatigue life was marginally reduced. The fatigue life of the welded alloy is not affected by the rotating speed.

Weld joint quality was studied by Young Gon Kim et al. (2014), who looked at the best circumstances for welding as well as the impact of the FSW variables. To accomplish the studies, we used a Si3N4 tool and 1.4 mm thick steel (DP590) sheet on a stir plate. The growth of the FS welded zone and the amount of heat applied per unit length was carefully examined.

Finite element analysis and experimental approaches were used to investigate the FS butt welding of pure copper plates, as described by Gihad Karrar et al. (2014). At a constant rotating speed, an FSW experiment was conducted to determine the weld quality at various speeds. Using micro-hardness, UTS, and changes in the produced microstructure, weld quality was assessed. The temperature distributions in the weld line and the welding strains may be accurately predicted using a finite element model that was built to replicate the FSW process. The finite element model's accuracy was verified using temperature readings and other study findings.

Research by Esther T. Akinlabi et al. (2014) looked at the effect of FSW variables on the joints between Al-alloy (AA5754) and pure copper (C11000). The feed rate was varied from 50 to 300 mm/min, and the rotating speed was varied from 600 to 1200 rpm, resulting in the welds. Corrosion resistance and durability

We looked examined the weld joints' microstructures. As the rotating speed increased, so did the corrosion resistance of the weld plates. The weld corrosion rate was reduced compared to Al-alloy but enhanced compared to the parent metal Cu. Rotational and traverse/feed speeds of 950 rpm and 300 mm/min had the lowest corrosion rates.

A CuZn30 brass alloy that has been FS welded was studied by Y.F. Sun et al. (2014) for its micro structural and mechanical characteristics. The best FSW conditions for the CuZn30 brass were found to be between 750 and 1200 rpm, with a feed speed of 200 to 800 mm/min, for a 1000 kg load.

To study the microstructure of CuZn30 brass during FSW, S. Mironov and colleagues (2014) used electron backscatter diffraction (EBSD). Discontinuous recrystallization, grain boundary bulging, and subsequent recrystallization nucleation were all determined to be the mechanisms used to create the microstructure in all of the examples. As a consequence, the grain was greatly enhanced and significantly strengthened.

Welding speeds ranged from 500 millimeters per minute to 90 millimeters per minute for FSW on aluminum and copper in the work of Felix Xavier Muthu and Jayabalan (2015a). At welding speeds of 70 and 80 mm/min, the defect-free SZ was produced. It was found that the tensile strength was 113MPa, with a joint efficiency of 70 percent. The presence of Cu element atop the Al material was responsible for the high strength.

Variable rotation rates (400, 600, 800, and 1000 rpm) with a constant welding speed (100mm/min) were used in the FSW of 7020-T6 Al alloy plates by A. Salemi Golezani et al, (2015). Because heat input is reduced at lower rotational speeds, hardness and tensile strength improve.

Weld hardness and microstructure parameters in FSW single-phase CuZn33.8 brass alloy were studied by Sajjad Emami et al. (2015). Under modest heat input, 400 to 800 rpm and 100 to 300 mm/min welding/traverse speeds were achieved for the welded joints. The weld portions were examined under an optical microscope and tested for Vickers hardness to determine the weld's properties.

Reduced grain size and increased mean hardness were seen in the stir zone (SZ) when the rotating speed was lowered and the welding speed increased, according to the results.

The microstructural and mechanical parameters of single and double phase FS welded brass (CuZn33) alloys were compared by Heidarzadeh et al. (2016) in their study. SEM, optical microscope, X-ray diffraction, and scanning electron microscopy were all used to examine the joint microstructure (SEM). The final results showed that the SZ grains in single phase joints were larger than those in double phase alloy. When compared to single phase joints, the double phase joints showed superior strength but poorer elongation.

Weld AA7020 Al alloy tensile characteristics, namely the UTS and % elongation, were measured experimentally by Biranchi PANDA et al. (2016).

They argued that a weld with high UTS may be obtained with a lower heat input than a weld with a lower heat input. There is a functional link between the tensile strength and three inputs (the rotational speed, the axial force, and the welding/tool traverse speed) using genetic programming numerical models. High UTS was attained with an axial force of 8 KN fixed to FSW at a rotation speed of 1050 rpm and a feed speed of 95 mm/min.

Mica Grujicic et al. (2016) studied the mechanical characteristics of work metal in different zones of FS welded joints of AA2139-T8 Al plates using a combination of computational and experimental methods. For example, the weld zone formed in FSW of metallic materials such as aluminum and its alloys often has discrete microstructures and characteristics for each separate zone.

Using computational fluid analysis and the finite element approach, Z. Zhang et al. (2016) found that raising the welding speed lowered fatigue life while increasing the rotating speed enhanced fatigue life for tools used in FSW. The fatigue life of the tool used in FSW can also be extended by increasing the shoulder and pin diameters.

FS welded 316L stainless steel butt joints were studied by S. Shashi Kumar et al. (2016) to determine the influence of tool material on mechanical and microstructural aspects of the butt joints. For the FSW trials, a 600 rpm tool rotation speed, 45 mm/min feed speed, 11KN axial force, and 1.5o tool tilt angle were selected. Welds made using tungsten-lanthanum oxide tool exhibited better mechanical and microstructure qualities than those made with tungsten heavy alloy tool, according to the results.

Various non-ferrous metals, such as copper, aluminum, and brass, are used in the FSW process, according to L.V. Kamble et al. (2017), and tests are conducted properly, but the most crucial factor is a firm clamping. They're hoping to shed some light on the fixture's methodical design for FSW. To help researchers execute FSW effectively, a flexible fixture should be created that is able to accept a wide range of material sizes and thicknesses.

Tool pin design has a significant impact on the microstructural and mechanical characteristics of FS welded joints, according to S. Emamian et al. (2017a). It was found that the square pin profile produced sound weld joints, while the threaded cylindrical pin profile was also capable of producing sound joints.. In terms of tool performance, FSW employing a threaded cylindrical profile produces the best weld joints.

Kush Mehta and Badheka (2017) studied the FSW of two dissimilar metals, Cu and Al, utilizing nine different tool designs while maintaining other factors constant. Evaluation of weld joints was done using metallurgical and mechanical testing. The cylindrical tool pin profile was found to be the most effective in terms of weld strength. Dissimilar friction stir welded butt joints were found to be incompatible with the polygonal tool pin profiles.

However, increasing the number of polygonal edges enhanced tensile strength. In compared to a cylindrical pin profile with the same shoulder diameter, a polygonal tool pin profile provides a hard and brittle stir zone. Using a square pin profile, a maximum hardness of 283 HV was discovered.

With the help of FSW, Suresh D. Meshram and colleagues (2017) welded maraging and ultra-high strength steel together process.

FSW was able to solve most of the issues that arose during fusion welding of steel. Both base metal and gas tungsten arc joints were found to have lower stress corrosion cracking resistance versus friction stir welds. When compared to traditional fusion welds, the resulting grain structure was fine and no alloying components were segregated. As an alternative to the fusion welding method, FSW can be employed.

III. CONCLUSION

At tool rotation rates of 1000—1500 rpm and feed speeds of 500—2000 mm/min, Hwa Park Soon et al. (2004) investigated the microstructure and mechanical characteristics of CuZn40-based FS welds, as well as the combined effects of these speeds and the feed speed. FS welded high zinc brass have been subjected to temperature analysis by Afshin Emamikhah et al. (2013), who took tool design by inserting thermo-couples in the fixture and maintaining the other parameters constant.

We can see from the literature that there are several avenues for study into FSW, but we've focused on brasses. Study gaps in high zinc brasses (CuZn40) and the influence of tool tilt angle, which is a crucial factor for sound welds, have been recognized from the gaps in research. That's why throughout my experiment, I looked at how tool tilt angle affected the qualities of FS welded brass plates.

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