

# A Research Paper on “Study And Comparison of Tensile Strength Obtained for Given MS Plate by Microwave Hybrid Metal Joining over Traditional CO<sub>2</sub> Metal Joining”

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**Abstract**—This Paper covers information about modern welding such as Microwave metal joining technique and results of the same based on comparison of the tensile strength of joint developed using this process and CO<sub>2</sub> Welding. This type of Welding can be applicable for Special Purposes like Aerospace, Automobile, and various such specific fields. This method also exhibit to join the dissimilar metal.

**Keywords:** MS Plate, CO<sub>2</sub> Welding, Microwave Metal Joining Technique

## I. INTRODUCTION

Mechanical Engineering program hugely relates to metallurgical processes such as Casting, Forging and many others. This also includes various metal joining processes. Metal joining finds a large history from about 5<sup>th</sup> Century. Since then many metal joining processes has been invented and implemented. Some of the best known welding processes are Oxy-fuel Welding, Shielded metal Arc Welding, Gas Tungsten Arc Welding, etc. But we have tried to implement Microwave Hybrid Heating method for joining (welding). We have even compared our method of welding with CO<sub>2</sub> Welding and found our welding processes to be better.

Processing of materials using microwave energy in recent years has emerged as a new area for joining of bulk metals. In con-ventional heating, energy is transferred because of temperature gradients whereas in microwave heating, energy from electromagnetic waves is directly converted into heat energy which is very rapid and thus volumetric heating takes place.

Microwave processing of materials has been applied for sintering and joining of ceramics in the recent past. However, the available literature related with joining of bulk metals using microwave energy is inadequate and hence there is a wide scope for further investigation in this area.

Microwaves when incident directly on metals at room temperature get reflected; however metals can be made to absorb microwaves by employing hybrid heating technique which uses microwave absorbing material called as susceptor. The susceptor absorbs microwaves, gets heated up and subsequently transfers heat to the bulk metal beneath it through conventional modes. When the bulk metal below the susceptor reaches a critical temperature, coupling with microwaves is initiated and bulk metal starts absorbing microwaves.

## II. THEORETICAL BACKGROUND

Microwaves are a form of electromagnetic radiation with wavelengths ranging from one meter to one millimeter; with

frequencies between 300 MHz (100 cm) and 300 GHz (0.1 cm). Different sources define different frequency ranges as microwaves; the above broad definition includes both UHF and EHF (millimeter wave) bands. A more common definition in radio engineering is the range between 1 and 100 GHz (300 and 3 mm). In all cases, microwaves include the entire SHF band (3 to 30 GHz, or 10 to 1 cm) at minimum. Frequencies in the microwave range are often referred to by NATO or EU designations. The wavelength of microwaves used in Domestic ovens is 7.5cm to 15 cm which is referred as ‘S’ band and the frequency ranges from 2-4 GHz.

The microwaves bounce back and forth off the reflective metal walls of the food compartment, just like light bounces off a mirror. When the microwaves reach the food itself, they don't simply bounce off. Just as radio waves can pass straight through the walls of your house, so microwaves penetrate inside the food. As they travel through it, they make the molecules inside it vibrate more quickly.

In the same way the weld pool is covered with the susceptor material, usually Charcoal powder. This then heats up initially and conducts the heat to the weld pool resulting in the fusion of metal work workpieces.

## III. METHODOLOGY

### A. Material and oven Specification

The specifications of material are as:

#### 1) Microwave Oven

Make: LG

Model: Solardom

Gross wattage: 900 W

Area enclosed by oven: 40 x 40 x 20 cm

Voltage: 220V 6 A

Capacity: 32 litres

2) Work piece: Mild Steel plates of selected dimensions.

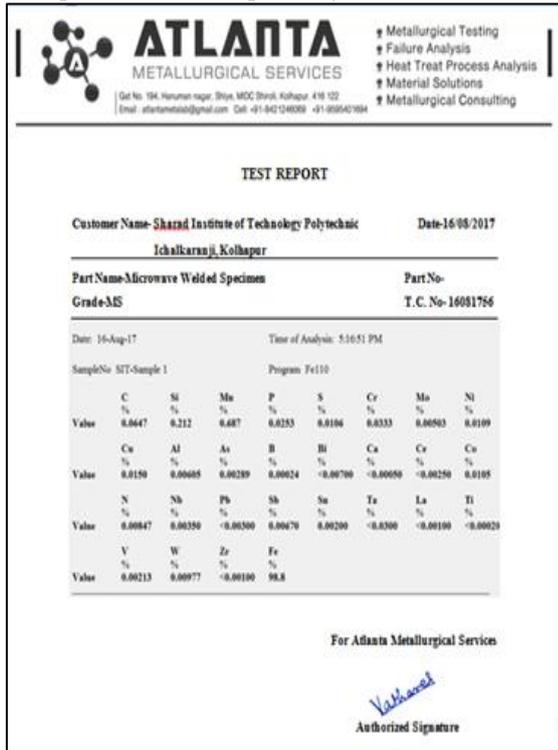


Fig. 1

- 1) Susceptor: Fine grained Charcoal.
- 2) Filler Metal: Having grade Ferchim 63/3.2 Metal Powder.
- 3) Adhesive: Bondtite "Fast and Clear" Part B
- 4) Glass wool

B. Pre-processing of work piece:

- 1) Take 2 MS plates with given dimensions and clean it using sandpaper.
- 2) Preparation of Filler material (Paste) – Take approximately 4-5 gm of metal powder and mix it thoroughly with approximately 2-3 ml of adhesive.
- 3) Place two MS plates on glass wool separated at a distance of approximately 2 mm.
- 4) The paste is to be filled carefully within the gap in the metal plates.
- 5) Spread charcoal on the paste area evenly.
- 6) Place entire setup into the turntable of oven.

C. Post Processing of Work Piece

The experimental setup as shown in fig.

1. Microwaves 2. Glass wool 3. Base metal 4. Base 5. Susceptor 6.Masking 7.Separator 8. Ferchim powder 9. Turn table

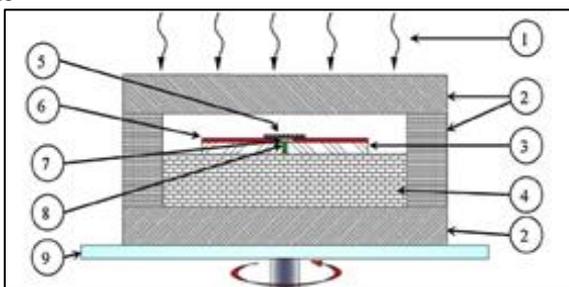


Fig. 2:

- 1) This setup is to be placed in the oven for 15 minutes.

D. CO<sub>2</sub> welding:

This welding is another name for MIG welding which is the most common type of welding in the industry. So we used this method for comparison

E. Test Report

1) Vickers Hardness Testing

a) Microwave Welded workpiece



Fig. 3, 4: Microwave welded work piece CO<sub>2</sub> Welded Work piece

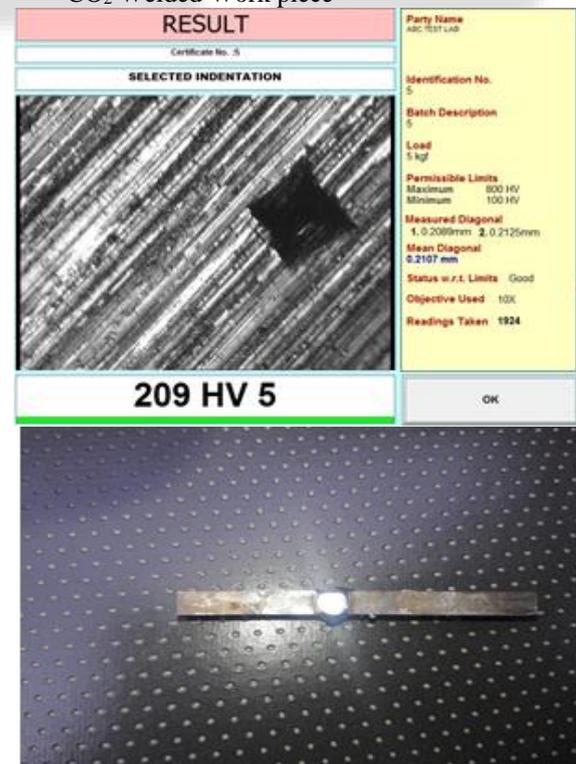


Fig. 5, 6: CO<sub>2</sub> welded work piece

## 2) Tensile Strength Testing

Tensile strength was calculated with reference to the Vickers hardness testing method. Vickers hardness test was conducted at 5 kg of load application.

The following table is taken with reference from [www.magmaweld.com](http://www.magmaweld.com)

Methods	Vickers Hardness (HV)	Tensile Strength (N/mm <sup>2</sup> )
CO <sub>2</sub>	209	675
Microwave	270	865

## IV. CONCLUSION

By analyzing these two different methods of welding for MS plates, we come to the following conclusions from the experimentation:

- 1) This technique is very helpful for joining two similar as well as dissimilar metals.
- 2) Strength is the basic criteria for designing, hence, this method gives more strength than that of CO<sub>2</sub> welding technique.
- 3) It also gives the better surface characteristics.
- 4) This technique is eco-friendly due to absence of Smoke which is hazardous for the environment.

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