# PROBLEM IN WELDING OF TWO DISSIMILAR MATERIALS

**PREPARED BY**
**MR. JIGAR PATEL**
**MR. PARESH PATEL**
**MR. RAJESH CHAUDHARY**
**MR. JAYDIP SODHA**

## Guide by

**PROF. A.G. BARAD**
**MECHANICAL DEPT.**

न हि ज्ञानेन सदृशं पवित्रमिह विद्यते।
Smt. S. R. PATEL
ENGINEERING COLLEGE

# Objective of the work

- Very less work has been done on laser welding on dissimilar material.
- In this project Two dissimilar material stainless steel and copper For Laser Welding will be used.
- The optimization of the process parameters in laser welding operation will be carried out.
- We will try to weld very small sheets of dimension 80mm*30mm*1mm which were cut from the bigger sheet.

# Why we select LBM?

## PROBLEM STATEMENT

- Welding techniques as TIG, MIG and resistance welding have been used for many years but they have many problem.

- larger fusion area
- larger heat-affected zones
- higher Shrinkage
- bigger deformations
- more defects such as cracks

# Aims of Laser Welding

- Deep penetration
- High speed
- Small heat-affected zone
- Fine welding seam quality
- Low heat input per unit volume
- Fiber optic beam delivery
- Ease of interface with robots

# Basic Laser Principle

- LASER- Light Amplification by Stimulated Emission of Radiation.
- LASER, is a mechanism for emitting light within the electromagnetic radiation region of the spectrum, via the process of stimulated emission.
- The laser light is a narrow-wavelength electromagnetic spectrum monochromatic light.
- In manufacturing, lasers are used for cutting, bending, and welding metal and other materials.
- Lasers have also begun to be tested for directed-energy weapons. Lasers are used in medicine for surgery, diagnostics, and therapeutic applications .

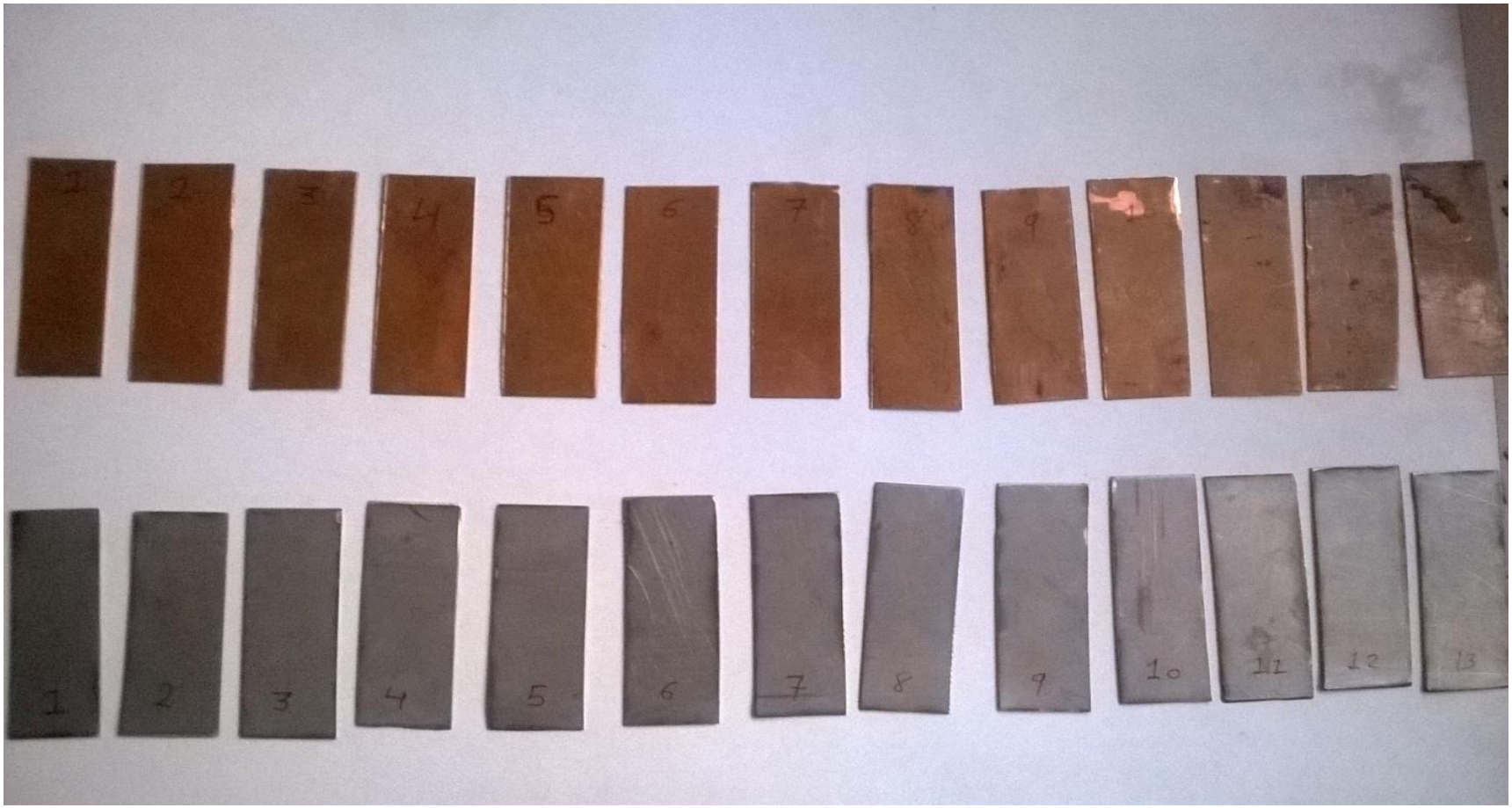
# Process parameters and design level

After the study of on of research paper, the main parameter affect on leaser welding are as given below.

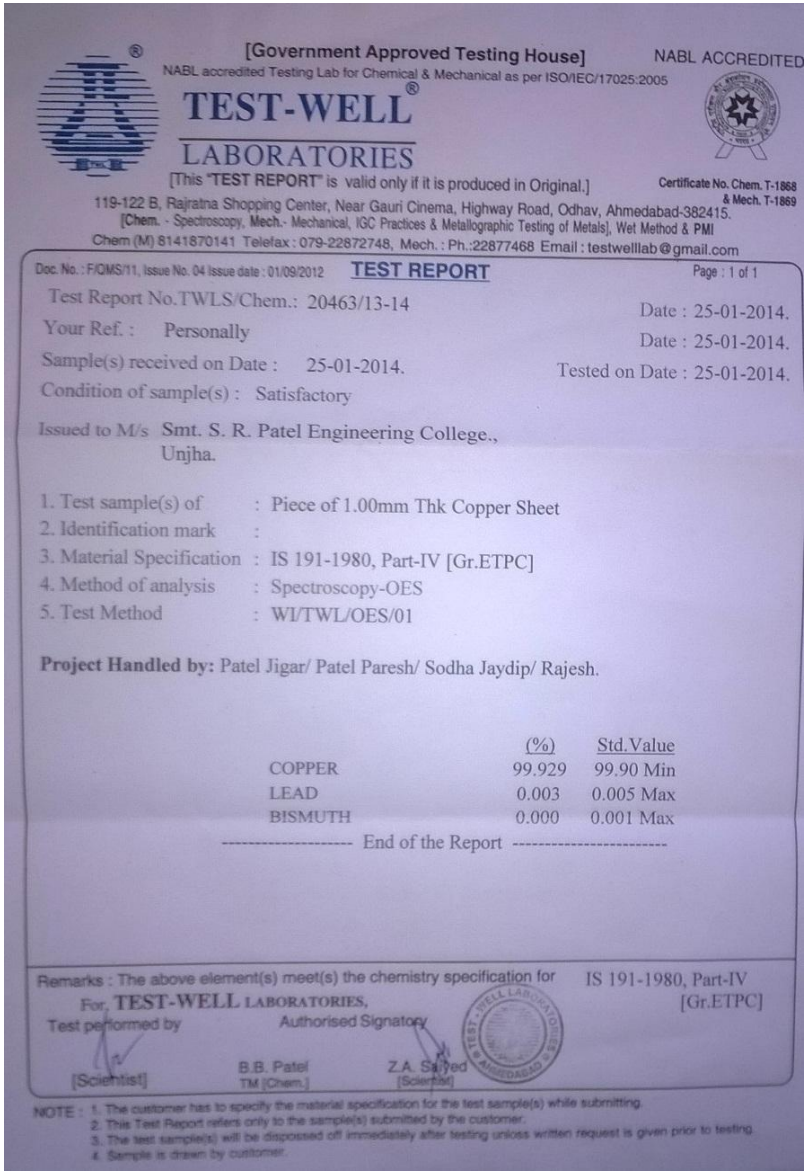
| S.N. | Variable | Code | Unite | Level 1 | Level 2 | Level 3 | Level 4 |
|---|---|---|---|---|---|---|---|
| 1 | Laser power | p | Kw | 5.6 | 5.8 | 6.0 | 6.2 |
| 2 | Welding speed | S | mm/sec | 0.6 | 0.8 | 1.0 | 1.2 |
| 3 | Pulse duration | Tp | ms | 13 | 14 | 15 | 16 |

# Jigsaw machine and grinding wheel machine


# Workpiece before the welding (cooper & steel)



# Chemical composition



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Chem (M) 8141870141 Telefax : 079-22872748, Mech. : Ph.:22877468 Email : testwelllab@gmail.com

Doc. No. : F/QMS/11, Issue No. 04 Issue date : 01/09/2012

**TEST REPORT**

Page : 1 of 1

Test Report No.TWLS/Chem.: 20463/13-14 Date : 25-01-2014.

Your Ref. : Personally Date : 25-01-2014.

Sample(s) received on Date : 25-01-2014. Tested on Date : 25-01-2014.

Condition of sample(s) : Satisfactory

Issued to M/s Smt. S. R. Patel Engineering College., Unjha.

1. Test sample(s) of : Piece of 1.00mm Thk Copper Sheet
2. Identification mark :
3. Material Specification : IS 191-1980, Part-IV [Gr.ETPC]
4. Method of analysis : Spectroscopy-OES
5. Test Method : WI/TWL/OES/01

**Project Handled by:** Patel Jigar/ Patel Paresh/ Sodha Jaydip/ Rajesh.

| | (%) | Std.Value |
|---|---|---|
| COPPER | 99.929 | 99.90 Min |
| LEAD | 0.003 | 0.005 Max |
| BISMUTH | 0.000 | 0.001 Max |

---------- End of the Report ----------

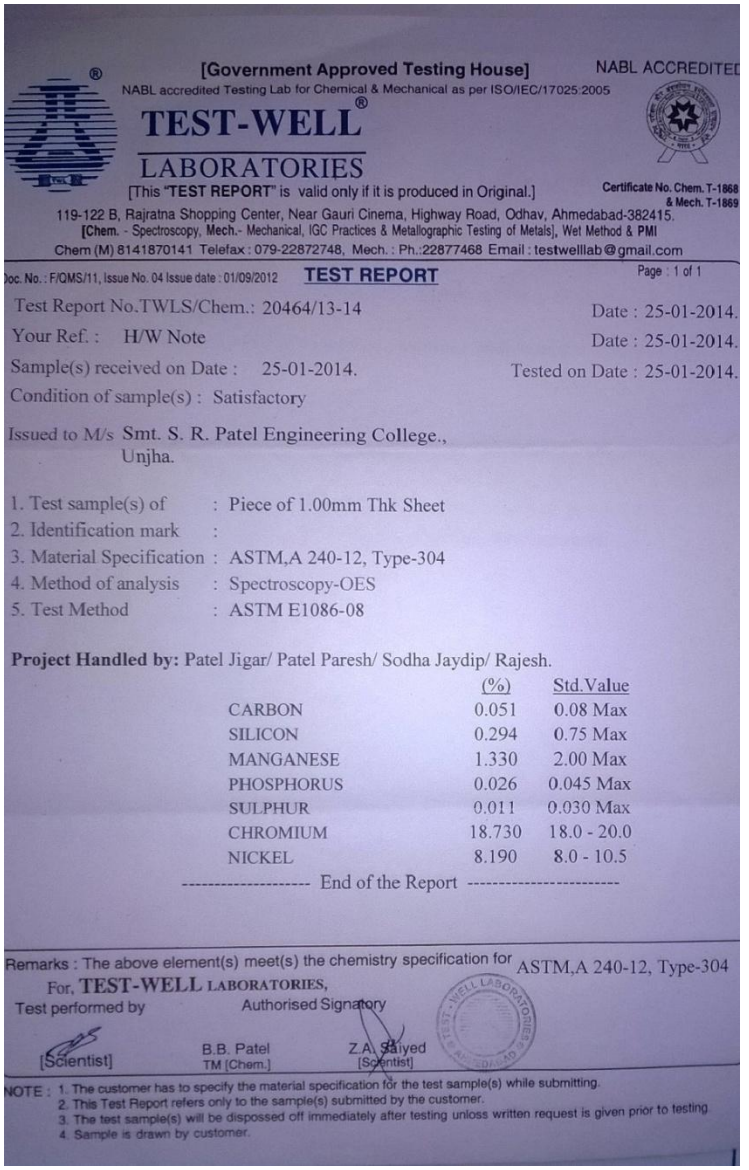
Remarks : The above element(s) meet(s) the chemistry specification for IS 191-1980, Part-IV [Gr.ETPC]

For, TEST-WELL LABORATORIES,

Test performed by Authorised Signatory

[Scientist] B.B. Patel TM [Chem.] Z.A. Saiyed [Scientist]

NOTE : 1. The customer has to specify the material specification for the test sample(s) while submitting.
2. This Test Report refers only to the sample(s) submitted by the customer.
3. The test sample(s) will be dispossed off immediately after testing unless written request is given prior to testing.
4. Sample is drawn by customer.



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**TEST REPORT**

Page : 1 of 1

Test Report No.TWLS/Chem.: 20464/13-14 Date : 25-01-2014.

Your Ref. : H/W Note Date : 25-01-2014.

Sample(s) received on Date : 25-01-2014. Tested on Date : 25-01-2014.

Condition of sample(s) : Satisfactory

Issued to M/s Smt. S. R. Patel Engineering College., Unjha.

1. Test sample(s) of : Piece of 1.00mm Thk Sheet
2. Identification mark :
3. Material Specification : ASTM,A 240-12, Type-304
4. Method of analysis : Spectroscopy-OES
5. Test Method : ASTM E1086-08

**Project Handled by:** Patel Jigar/ Patel Paresh/ Sodha Jaydip/ Rajesh.

| | (%) | Std.Value |
|---|---|---|
| CARBON | 0.051 | 0.08 Max |
| SILICON | 0.294 | 0.75 Max |
| MANGANESE | 1.330 | 2.00 Max |
| PHOSPHORUS | 0.026 | 0.045 Max |
| SULPHUR | 0.011 | 0.030 Max |
| CHROMIUM | 18.730 | 18.0 - 20.0 |
| NICKEL | 8.190 | 8.0 - 10.5 |

---------- End of the Report ----------

Remarks : The above element(s) meet(s) the chemistry specification for ASTM,A 240-12, Type-304

For, TEST-WELL LABORATORIES,

Test performed by Authorised Signatory

[Scientist] B.B. Patel TM [Chem.] Z.A. Saiyed [Scientist]

NOTE : 1. The customer has to specify the material specification for the test sample(s) while submitting.
2. This Test Report refers only to the sample(s) submitted by the customer.
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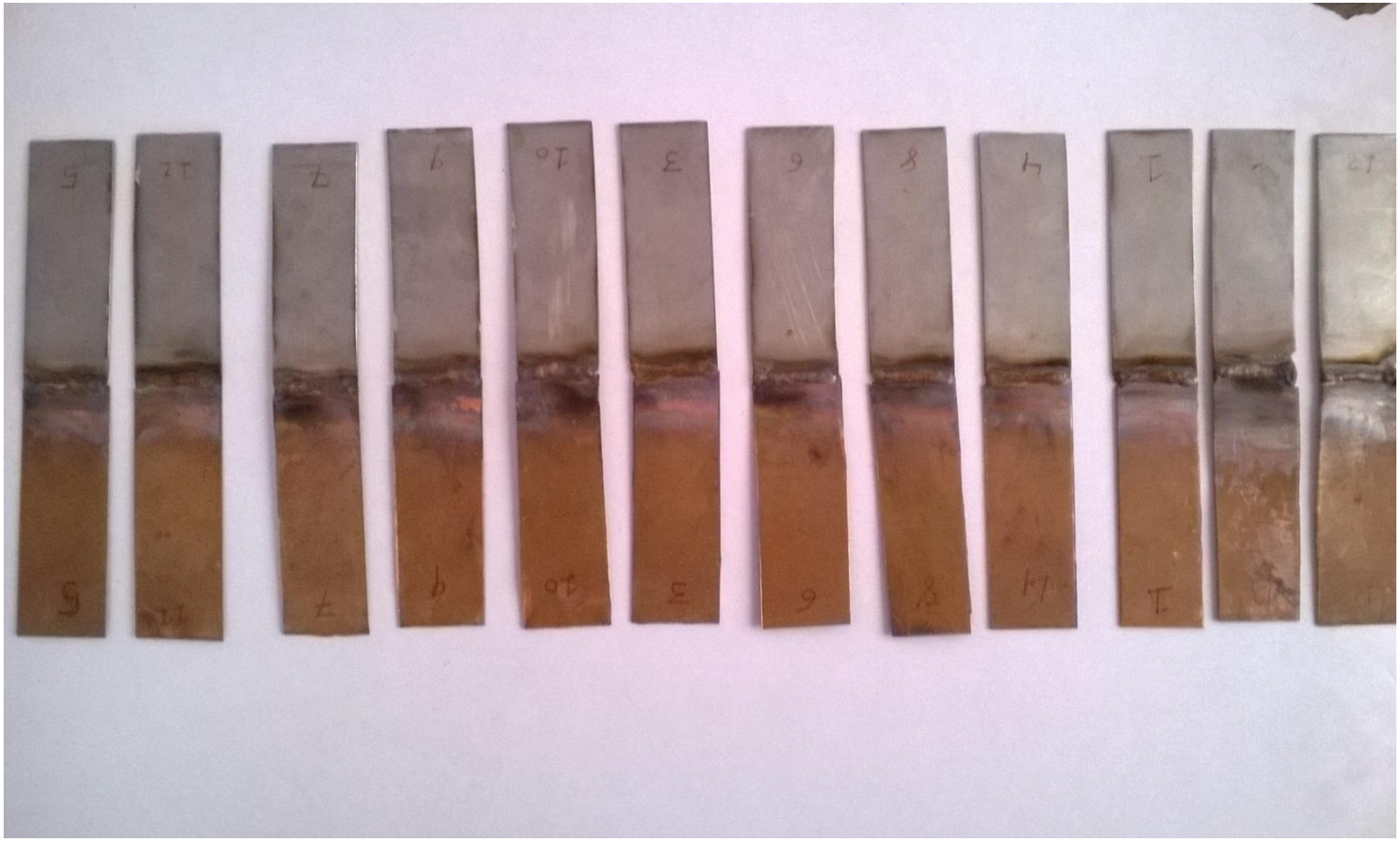
4. Sample is drawn by customer.

# LBM

| | |
|---|---|
| Wavelength | 1.06μm |
| Maximum average power | 200W |
| Pulse energy | 90J |
| Peak pulse power | 100kW |
| Pulse duration | 0.5-20ms |
| Pulse frequency | 20Hz |
| Focus diameter | 0.3-2.2mm |

# Optical microscope and UTM

# Workpiece After the welding (cooper & steel)



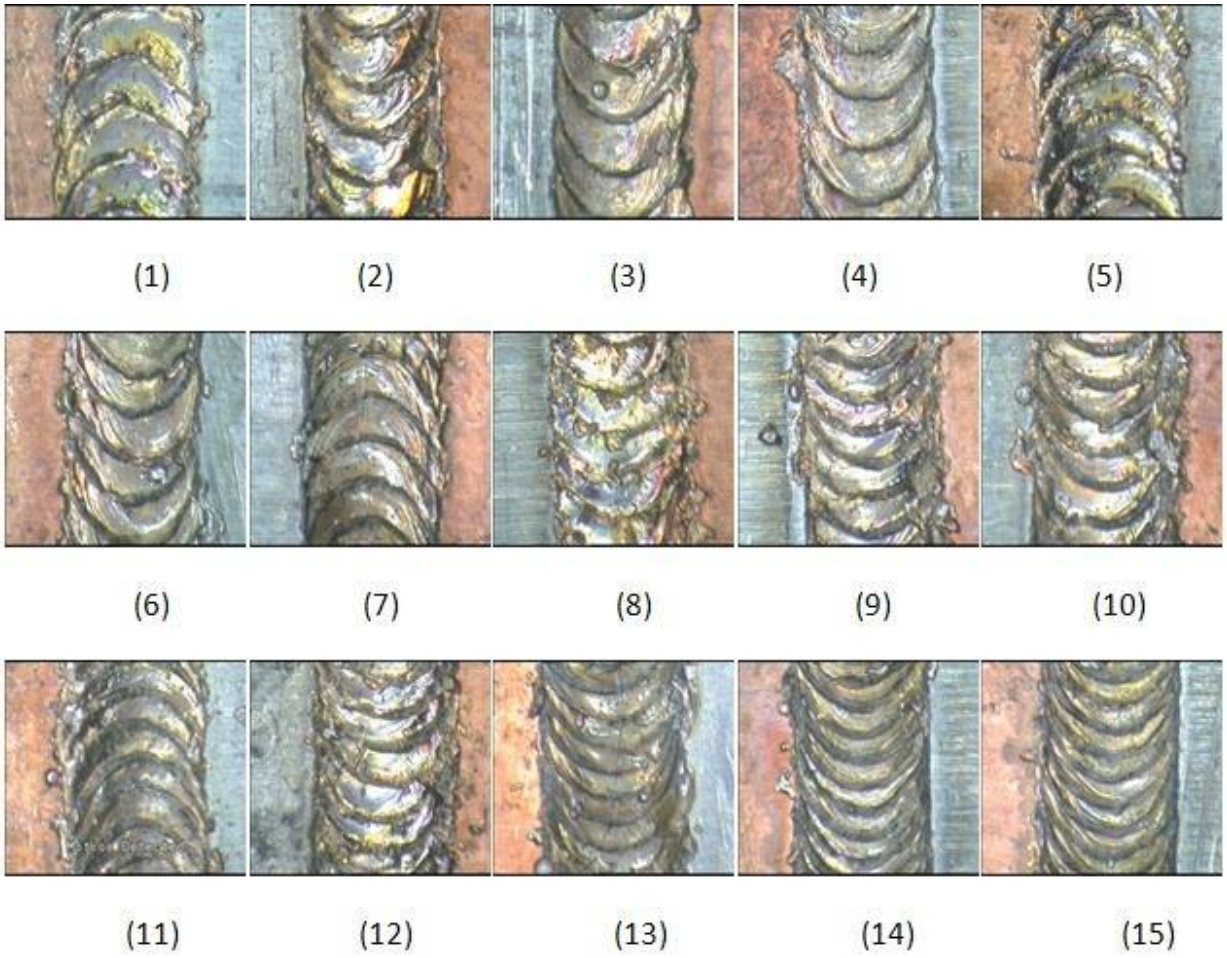
# No of Experiment

- When focus position of laser at the center of welding line (A).
- When focus position of laser at 0.5 mm toward the copper side (A’).
- When focus position of laser beam 0.5 mm toward the stainless steel plate side**.**

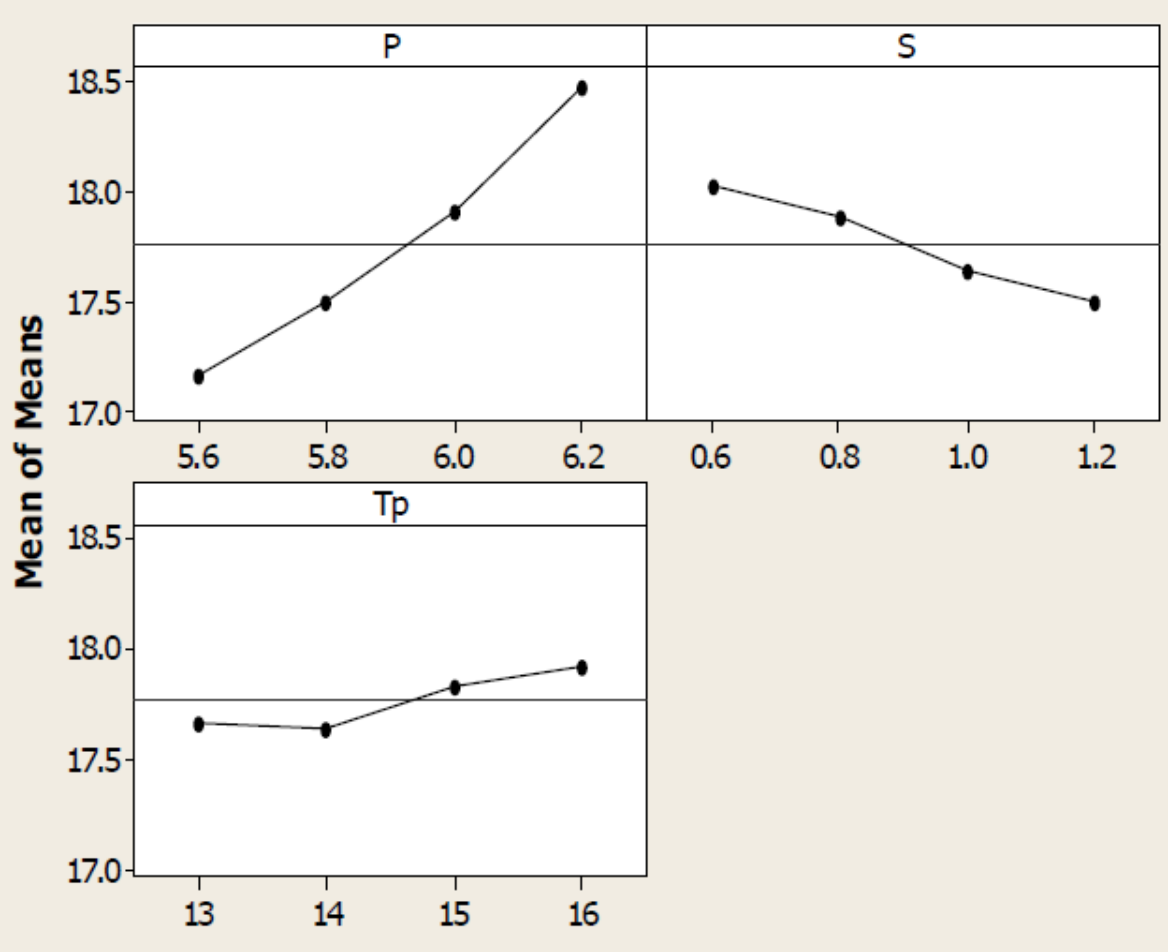
# Experiment No. 1.

| Exp no. | P(kw) | S(mm/s) | $T_p$(ms) | Tensile strength |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 17.20 |
| 2 | 2 | 1 | 2 | 17.65 |
| 3 | 3 | 1 | 3 | 18.21 |
| 4 | 4 | 1 | 4 | 19.06 |
| 5 | 2 | 2 | 1 | 17.62 |
| 6 | 3 | 2 | 2 | 17.90 |
| 7 | 4 | 2 | 3 | 18.63 |
| 8 | 1 | 2 | 4 | 17.38 |
| 9 | 3 | 3 | 1 | 17.74 |
| 10 | 4 | 3 | 2 | 18.14 |
| 11 | 1 | 3 | 3 | 17.23 |
| 12 | 2 | 3 | 4 | 17.46 |
| 13 | 4 | 4 | 1 | 18.08 |
| 14 | 1 | 4 | 2 | 16.85 |
| 15 | 2 | 4 | 3 | 17.25 |
| 16 | 3 | 4 | 4 | 17.80 |

# Optical microscope



# Main effect plots for tensile strength



# Response Table for Signal to Noise Ratios Larger is Better

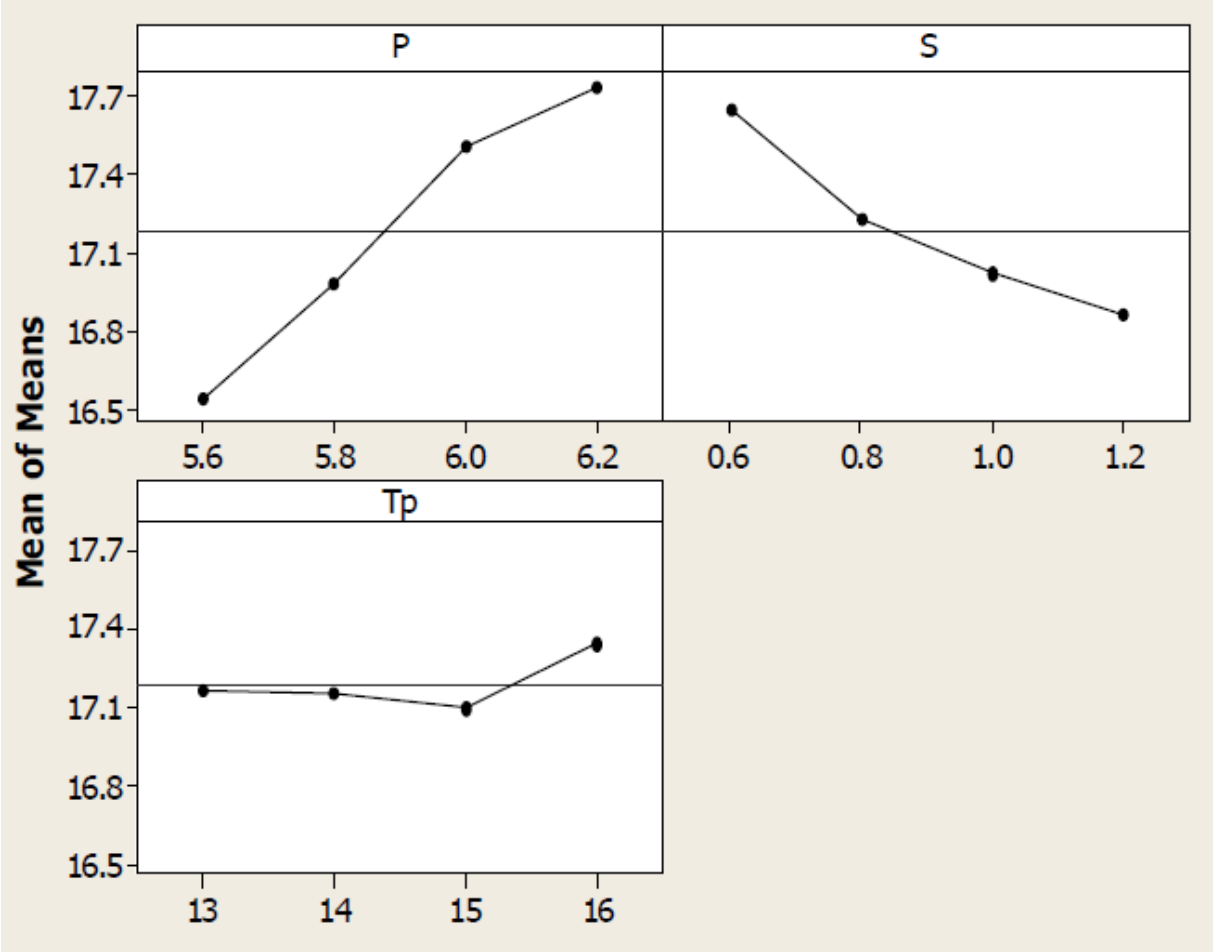
| Level | 1 | 2 | 3 | 4 | Delta | Rank |
|---|---|---|---|---|---|---|
| p | 24.69 | 24.86 | 25.06 | 25.33 | 0.64 | 1 |
| S | 25.05 | 25.05 | 24.93 | 24.86 | 0.26 | 2 |
| $T_p$ | 24.94 | 24.93 | 25.02 | 25.06 | 0.14 | 3 |

The best result gain when input process parameters are P -6.2, S-.6, and Tp-16

# Experiment No. 2.

| Exp no. | P(kw) | S(mm/s) | $T_p$(ms) | Tensile strength |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 16.85 |
| 2 | 2 | 1 | 2 | 17.31 |
| 3 | 3 | 1 | 3 | 17.8 |
| 4 | 4 | 1 | 4 | 18.62 |
| 5 | 2 | 2 | 1 | 17.12 |
| 6 | 3 | 2 | 2 | 17.61 |
| 7 | 4 | 2 | 3 | 17.56 |
| 8 | 1 | 2 | 4 | 16.63 |
| 9 | 3 | 3 | 1 | 17.36 |
| 10 | 4 | 3 | 2 | 17.42 |
| 11 | 1 | 3 | 3 | 16.41 |
| 12 | 2 | 3 | 4 | 16.89 |
| 13 | 4 | 4 | 1 | 17.31 |
| 14 | 1 | 4 | 2 | 16.26 |
| 15 | 2 | 4 | 3 | 16.62 |
| 16 | 3 | 4 | 4 | 17.24 |

# Main effect plots for tensile strength



# Response Table for Signal to Noise Ratios Larger is Better

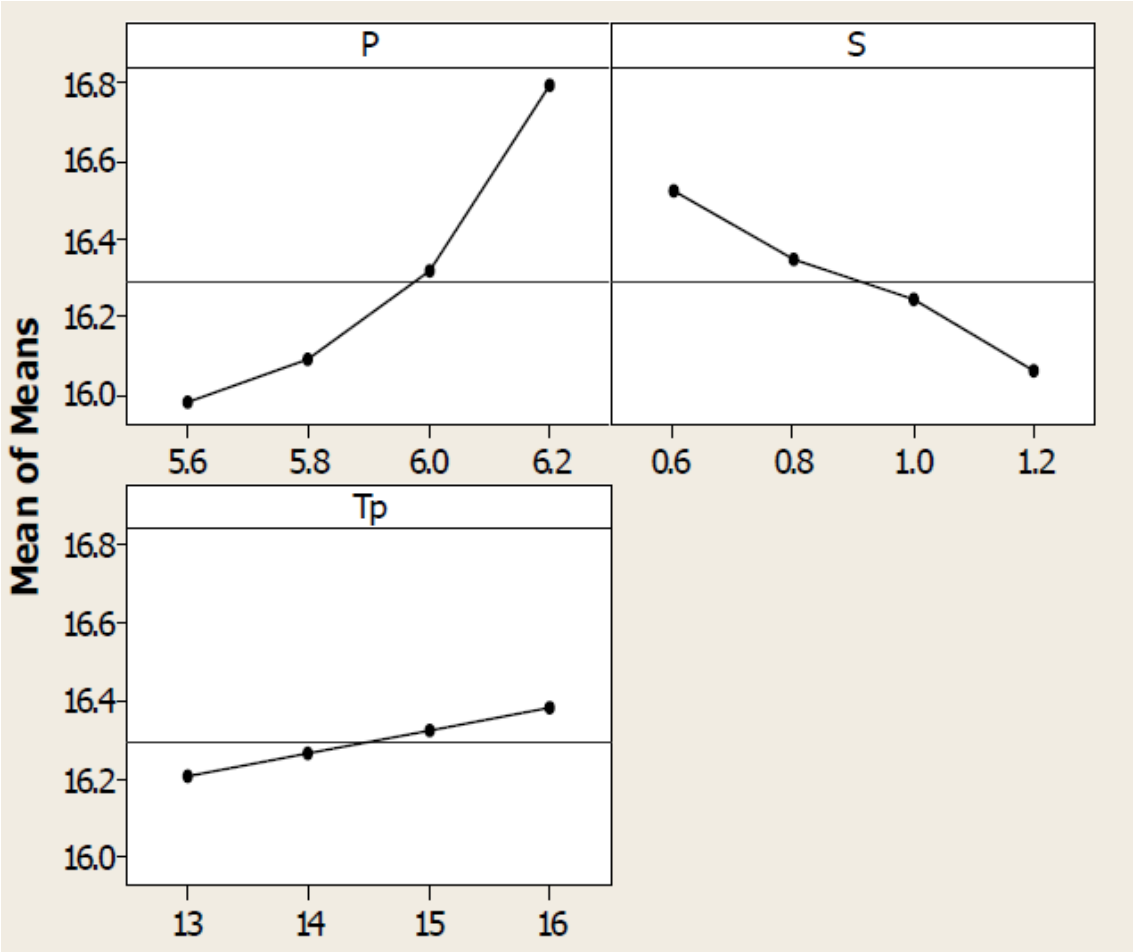
| Level | 1 | 2 | 3 | 4 | Delta | Rank |
|---|---|---|---|---|---|---|
| p | 16.54 | 16.99 | 17.50 | 17.73 | 1.19 | 1 |
| S | 17.65 | 17.23 | 17.02 | 16.86 | 0.79 | 2 |
| $T_p$ | 17.16 | 17.15 | 17.10 | 17.35 | 0.25 | 3 |

The best result gain when input process parameters are P -6.2, S-.6, and Tp-16

# Experiment No. 3.

| Exp no. | P(kw) | S(mm/s) | $T_p$(ms) | Tensile strength |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 16.12 |
| 2 | 2 | 1 | 2 | 16.2 |
| 3 | 3 | 1 | 3 | 16.56 |
| 4 | 4 | 1 | 4 | 17.2 |
| 5 | 2 | 2 | 1 | 16.15 |
| 6 | 3 | 2 | 2 | 16.32 |
| 7 | 4 | 2 | 3 | 16.84 |
| 8 | 1 | 2 | 4 | 16.09 |
| 9 | 3 | 3 | 1 | 16.21 |
| 10 | 4 | 3 | 2 | 16.78 |
| 11 | 1 | 3 | 3 | 15.95 |
| 12 | 2 | 3 | 4 | 16.05 |
| 13 | 4 | 4 | 1 | 16.35 |
| 14 | 1 | 4 | 2 | 15.75 |
| 15 | 2 | 4 | 3 | 15.95 |
| 16 | 3 | 4 | 4 | 16.18 |

# Main effect plots for tensile strength



# Response Table for Signal to Noise Ratios Larger is Better

| Level | 1 | 2 | 3 | 4 | Delta | Rank |
|---|---|---|---|---|---|---|
| p | 24.07 | 24.13 | 24.25 | 24.50 | .43 | 1 |
| S | 24.36 | 24.27 | 24.11 | 24.11 | .24 | 2 |
| $T_p$ | 24.19 | 24.22 | 24.25 | 24.28 | .09 | 3 |

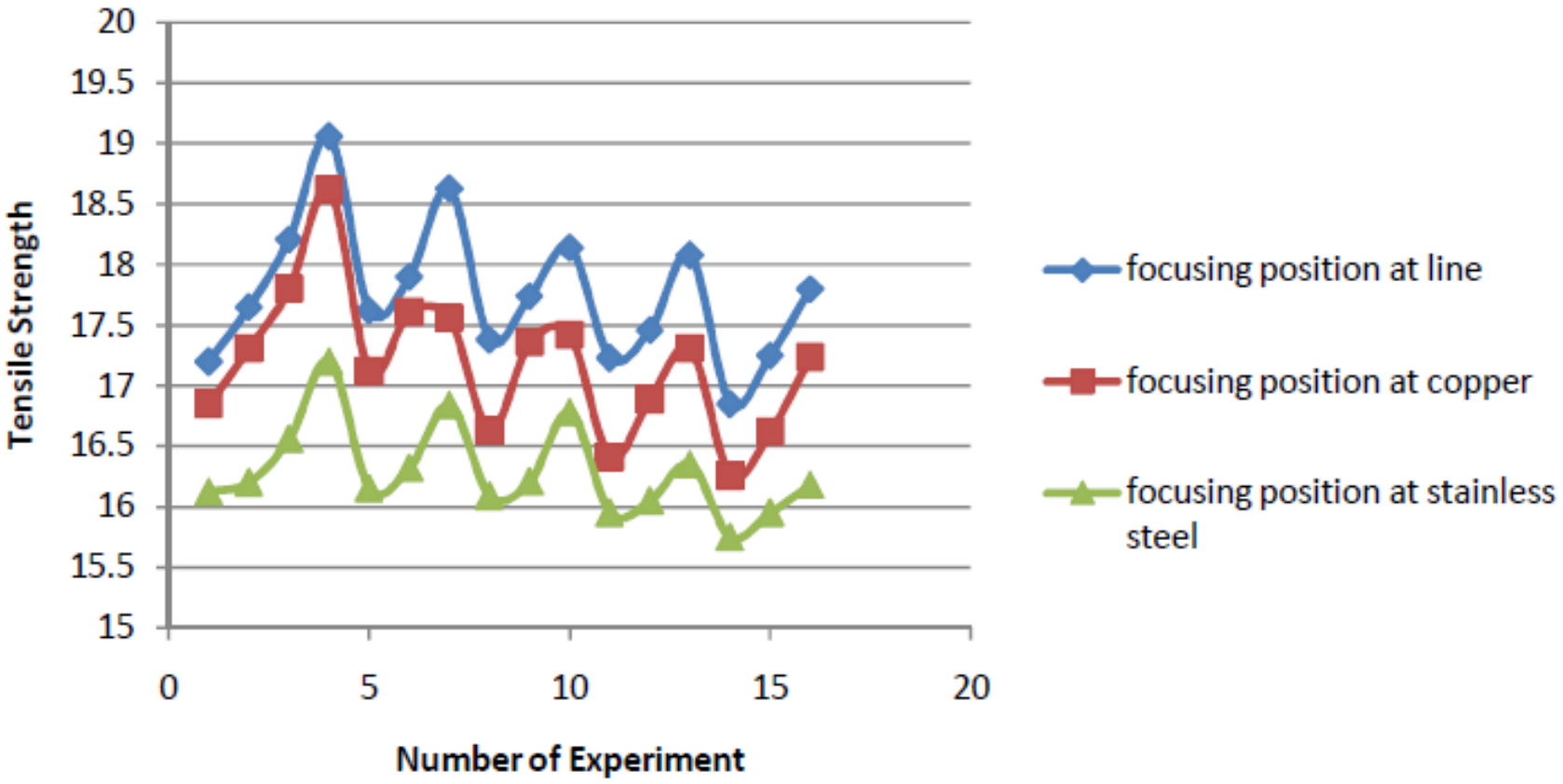
The best result gain when input process parameters are P -6.2, S-.6, and Tp-16

# ANOVA analysis

| EX-NO | P(KW) | S(mm/s) | Tp(ms) | Tensile strenght | (Tensile strength)2 | predicted value |
|---|---|---|---|---|---|---|
| 1 | 5.6 | 0.6 | 13 | 17.2 | 295.84 | 17.2512 |
| 2 | 5.8 | 0.6 | 14 | 17.65 | 311.5225 | 17.7862 |
| 3 | 6 | 0.6 | 15 | 18.21 | 331.6041 | 18.3212 |
| 4 | 6.2 | 0.6 | 16 | 19.06 | 363.2836 | 18.8562 |
| 5 | 5.8 | 0.8 | 13 | 17.62 | 310.4644 | 17.5026 |
| 6 | 6 | 0.8 | 14 | 17.9 | 320.41 | 18.0376 |
| 7 | 6.2 | 0.8 | 15 | 18.63 | 347.0769 | 18.5726 |
| 8 | 5.6 | 0.8 | 16 | 17.38 | 302.0644 | 17.3636 |
| 9 | 6 | 1 | 13 | 17.74 | 314.7076 | 17.754 |
| 10 | 6.2 | 1 | 14 | 18.14 | 329.0596 | 18.289 |
| 11 | 5.6 | 1 | 15 | 17.23 | 296.8729 | 17.08 |
| 12 | 5.8 | 1 | 16 | 17.46 | 304.8516 | 17.615 |
| 13 | 6.2 | 1.2 | 13 | 18.08 | 326.8864 | 18.0054 |
| 14 | 5.6 | 1.2 | 14 | 16.85 | 283.9225 | 16.7964 |
| 15 | 5.8 | 1.2 | 15 | 17.25 | 297.5625 | 17.3314 |
| 16 | 6 | 1.2 | 16 | 17.8 | 316.84 | 17.8664 |
| | | | | 284.2 | 5052.969 | 284.4288 |
| | | | | N=6 | | |

| some values | | Some of squares | | Mean squares varians | | Varians ratio of F | | Contribution % | |
|---|---|---|---|---|---|---|---|---|---|
| fa= | 3 | SA= | 0.09605 | VA= | 0.0321 | FA= | 2.8407 | PA= | 41.97 |
| fb= | 3 | SB= | 0.04294 | VB= | 0.01431 | FB= | 1.2663 | PB= | 18.76 |
| fc= | 3 | SC= | 0.02334 | VC= | 0.00778 | FC= | 0.6876 | PC= | 10.2 |
| T= | 284.2 | S0= | 0.0678 | V0= | 0.0113 | F0= | 1 | P0= | 29.63 |
| N= | 6 | F0= | 1 | | | | | TOTAL=100% | |
| C.F= | 5048.1 | | | | | | | | |
| S.T= | 0.2288 | | | | | | | | |
| A1= | 68.66 | | | | | | | | |
| A2= | 69.98 | | | | | | | | |
| A3= | 71.65 | | | | | | | | |
| A4= | 73.94 | | | | | | | | |
| B1= | 72.12 | | | | | | | | |
| B2= | 71.53 | | | | | | | | |
| B3= | 70.51 | | | | | | | | |
| B4= | 69.26 | | | | | | | | |
| C1= | 70.64 | | | | | | | | |
| C2= | 70.54 | | | | | | | | |
| C3= | 71.32 | | | | | | | | |
| C4= | 71.7 | | | | | | | | |

# Effect of focusing position




Main effect plot gives the optimum factor levels as P = 6.2, S = .6 and Tp = 16.

# ADVANTAGES

- The heat influence zone is very small because of a very short pulse duration.
- laser systems can be made completely automatic in order to have high accuracy welds.
- Improvements in welding speed, productivity and accuracy are achieved at the same time.
- Very high finish welds are obtained.
- Cost-effective for stainless steel applications.
- Three-dimensional geometries can be welded
- Laser welding can produces a very narrow heat affected zone (HAZ) with low residual stress and small welding defects in the base metal.

# APPLICATIONS

- **Many applications in various industry sectors such as**
- Electronics
- Medical
- Consumer goods
- Automotive

# Conclusion

- Laser welding is a very successful process to join AISI304 stainless steel and copper.
- It is necessary that the edges of the plate were cleaned and grinded along the weld line to ensure full contact.
- Focusing position of the laser beam also effect the response in case of joining of copper and stainless steel.
- Main effect plot gives the optimum factor levels as

  P = 6.2, S = .6 and Tp = 16.

THANK YOU