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STUDY THE VARIOUS MECHANICAL PROPERTIESOF DISSIMILAR METALS JOINING USING POWDER METALLURGYPROCESS

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ABSTRACT
During recent time, the Joining technologies using ceramic powder metallurgy to join two dissimilar metals have been developed effectively and especially in powder metallurgy industries. There are a lot of difficulties in developing joining techniques like welding. To control this difficulty powder metallurgy is one of the major key points. Here the active metal brazing has been established to solve the problem and produce scientifically high quality of joints. An appropriate interlayer is constructed for reducing thermal stress originating from thermal expansion and the mismatch between the ceramic layer and the metal is another critical problem.The superiority of Powder brazing dissimilar metals over conventional joining techniques since it does not participate to melt the base metal and thus it avoids the problems like variation in thermo-physical properties that assists to development of high amount of unacceptable compounds as a result of that high joint strength cannot be obtained, an effective solutions to make this type of joints has been developed.In the present work three different types of powder are chosen for brazing, Copper (Cu)-Stainless Steel (SS), Copper-Iron (Fe) and then the microscopic view of the joining has been observed.

Keywords: Ceramic-metal joining, Powder metallurgy, dissimilar metals, Brazing, Thermal expansion..

I. INTRODUCTION
In the present paper, the work is to join the Copper to Stainless steel and Copper to Iron through powder metallurgy joining process. The broad and wide use of the combination of these materials in industry needs to choose the mix of metal powders to perform unique joints of dissimilar metals. As the present time of manufacturing processes, the Powder metallurgical joining processes have imperative applications in aviation, automobile and various industries. The present work of jointing Cu-Steel has wide and important applications in auto commercial ventures as shrubberies, rollers in roller skates and a washer for hosing, electronic connectors and link joining.

As the manufacturing industries are growing day by day, the ability to join similar and dissimilar materials to produce tools, devices and structures has been widely accepted for the survival and progression of humankind. With the time and advances in Materials Engineering, the need for joining has grown and this is due to the discovery of new materials and the development of new product of dissimilar metals with desirable properties. When there is a joining of dissimilar materials, it is more important for an engineer to consider the compatibility of the components made up of dissimilar metals. Joining of dissimilar metals through welding processes needs to consider few points, for example, Copper behaviors heat vitality up to 10 times more than steels, which has a tendency to scatter warm rapidly far from the weld prompting troubles in the dissolving temperature of copper. A part from that there is a limited solubility of Cu in Fe. One more major problem in welding is hot cracking in the heat affected zone of steel as a result of copper penetration in to grain boundaries of steel.

In fact, the mismatch leads to the development of residual thermal stresses at the joint interface and as a result of that eventual failure. Actually, the mismatch of dissimilar metals is a common form of mechanical incompatibility, leading to stress concentrations and stress discontinuities at the interface of joining region. The

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higher modulus (stiffer) component restricts the lateral contraction of the lower modulus component, generating shear stress at the joint interface leading to possible failure. In fact, Poor chemical compatibility usually leads to undesirable interfacial reactions and unwanted products, which leads to occurrence of brittleness property in the joining area. Some reactions are accompanied by a volume change, generating local stresses, which can lead to eventual failure.

In the present work two unique sorts of powder are used for powder metallurgy joining, Copper (Cu)-Stainless Steel (SS), Copper-Iron (Fe) powders, then the specimens were subjected to metallographic study i.e. Optical microscopic view to study the joint respectability. Powder joining of dissimilar metals has different advantage over conventional joining approach since it does not include liquefying of the base metal and hence it maintains a tactical distance from the matter connected with, variety in thermo-physical properties and evoke arrangement of high measure of unacceptable mixes subsequently high joint quality can't be efficient, a capable answers for produce this sort of study the joint respectability.

II. WORKING PROCESS

In the present paper, the joining of dissimilar metals was done using powder metallurgy process for two specimens made up of Cu-SS and Cu-Fe. As we know the powder metallurgy is a component/product making process of similar or dissimilar metals. They are various types of processes which are used in the joining of dissimilar metals and among that powder metallurgy joining process is wide in use now a days. Powder metallurgy process consolidates works out, for instance, the creation of metal powders, portrayal of those powders, mixing and treatment of powder before compaction, and change of powders into valuable designing shapes, including a sintering step. Most generally the system relies on upon events that can be seen similarly as vital laws of warmth, work, and miss happening as associated with powders.

Powder Processing

There are various steps associated with the joining of a powder into a thing, including compaction and sintering. Powder handling is an overall incorporates sweeping number of variables that affect the last thing sizes and properties. The hard particles are making denser amid sintering. So, molecule hardness is a broad parameter. Powder preparing uses the few parameters to connect the last thing ascribes to the mix of molecule size, weight, shear rate, temperatures, time, and other adaptable parameter.

Different combinations of joint

Copper-Stainless Steel

In the field of power joining and transmission, cryogenics, electrical and equipment, the blends of copper-steel are periodically utilized as a part of light of their electrical conductivity of copper tends to quickly diffuse warmth a long way from the weld, provoking difficulties in setting off to the condensing temperature. The main problem in welding of copper to steel is that they have different melting points and as a result of that hot part in the glow affected zone in perspective of copper softening and invading into the grain furthest reaches of solid steel.

Copper-Iron

First of all the blends of Cu-Fe are prepared and then Solid state after welding was utilized to join low bury dissolvability metal couple Cu-Fe. After that the microstructures of the joints were analysed. The interface was free of deformities. Checking electron microscopy, significance dispersive spectrometry, and atomic force microscopy and nano space results reported that a potential zone of pseudo-parallel compound was open at the faying surface, where nanoscale particles were moved to the opposite side by faulted scattering. Attributable to the part of scaled down scale contact and faulted spread the interfacial quality was made progress.

Copper-Nickel

The joining of nickel to copper improves its quality and strength moreover the imperviousness to consumption, disintegration and cavitations in all basic water including sea water and salty, treated or debased waters. The included purpose of enthusiasm of astounding imperviousness to bio-fouling gives a material ideal for application in aquatic and concoction situations for boat and pontoon outlines, desalination plants, warmth trade hardware, sea water and weight driven pipelines, oil apparatuses and stages, fish developing enclosures and sea water confirmation screens, etc.

Objective of Work

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The present study is focused on joining of Copper (Cu)-Stainless Steel (SS), Copper-Iron (Fe) and Copper-Nickel powders through powder metallurgy route.

- To study the joining behaviour of different materials.
- To investigate the metallographic characterization of the joints.
- To investigate the mechanical characterization of the joints.

III. EXPERIMENTAL WORK

In the present work two different types of powder are chosen, Copper (Cu)-Stainless Steel (SS), Copper-Iron (Fe). Cu weight (2 gram), stainless steel powder (2 gram), and iron powder (2 gram). The specimens were subjected to sintering phenomena. The treatment was carried out at 900 °c in argon atmosphere with a heating rate of 10 kJ/min, and holding for 2 hours followed by air cooling, the specimens were cross sectioned using abrasive cutting machine, and some of the cut samples were mounted to study the cross section of the joints.The mounted samples were polished. The polishing procedure of this alloy include polishing with emery paper of 1/0, 2/0, 3/0, and 4/0 and the polished specimens were thoroughly cleaned with running water and specimens were subjected to chemicaletching using Nital solution. Macroscopic examination of joints was analyzed using optical microscope.

IV. RESULT

Copper (Cu) -Stainless Steel (SS)

Optical Micrographs:

Form the figure 1 microstructure it can be watched that there is no vicinity of splits in all the joints. It was watched that with the increments in compaction load there is a superior bonding between the joints. Microstructures couldn't affirm any vicinity of Intermetallics**.**

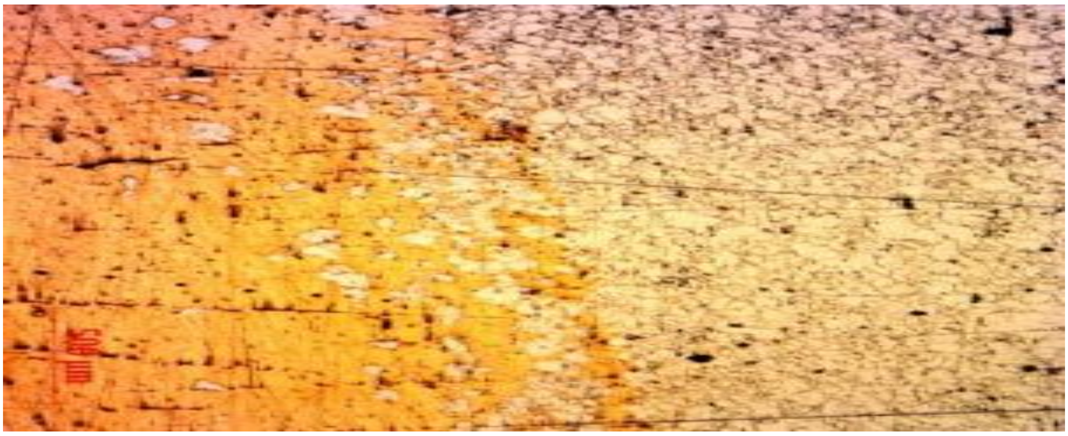

Fig. 1Optical image of interface between Cu-SS sample with 4 ton

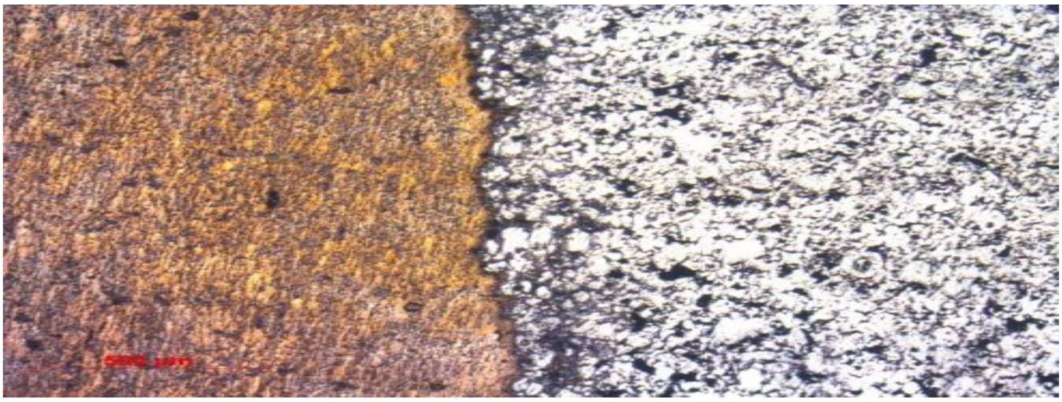

Fig. 2Optical image of interface between Cu-SS sample with 5 ton

Hardness Testing

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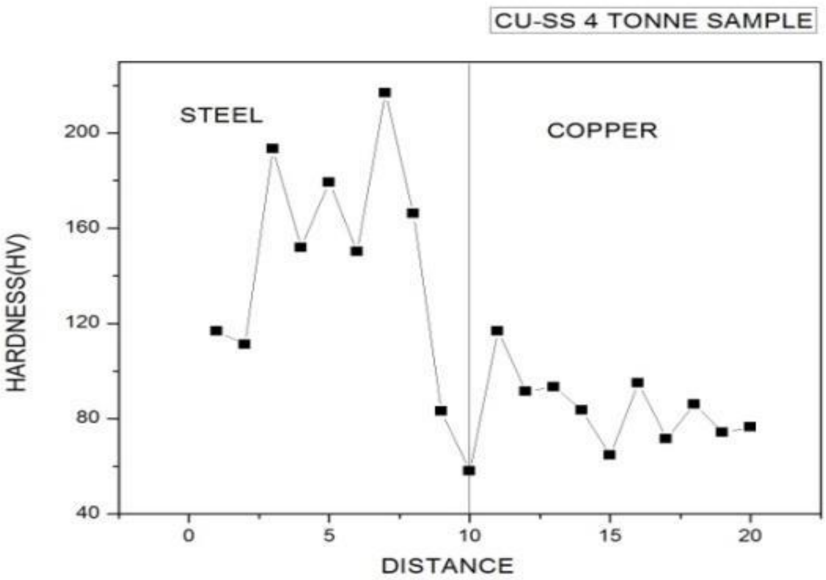
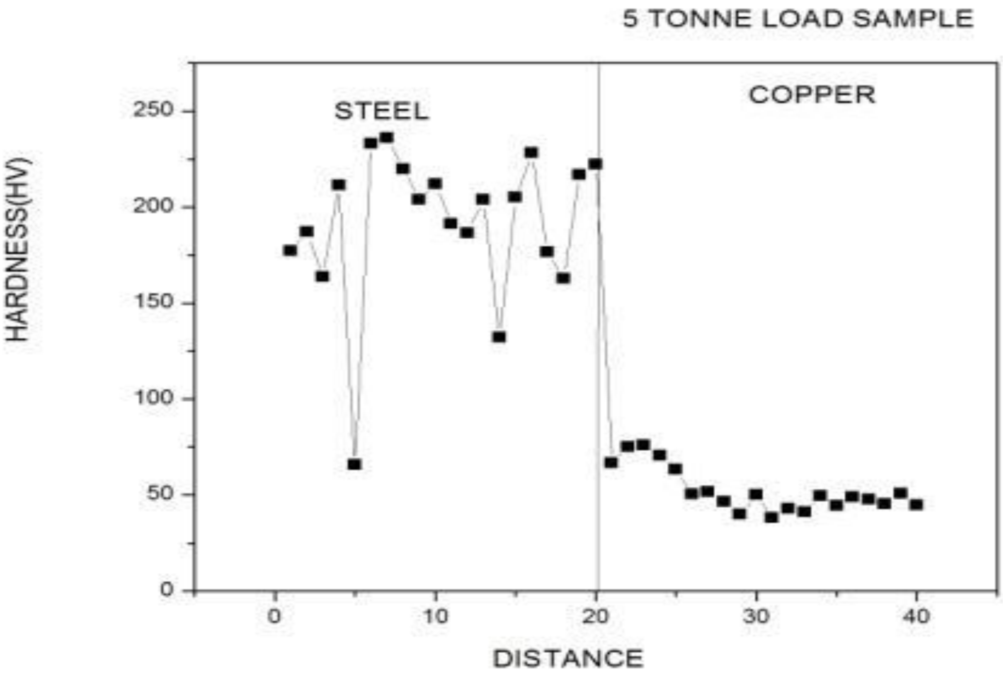
From the figure of hardness graphs it has been observed from Cu-SS sample that copper has low hardness contrast with Stainless steel at varying load of 4 tone and 5 tone. Form the hardness it has been confirmed that there could be a vicinity of Intermetallics because of negligible variety in the hardness at the interface in all the above cases. Form the hardness it has been also observed that there is a slight diffuse in the hardness information in the event of 4 ton than contrast with 5 ton information and this is can be because of vicinity of porosity or at higher loads the specimen could be reinforced better.



Graph1. Hardness graphs of Cu-SS sample at 4 ton



Graph2. Hardness graphs of Cu-SS sample at 5 ton

Copper (Cu) - Iron (Fe)

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Optical Micrographs:

Form the figure microstructure it can be watched that there is no vicinity of cracks in all the joints. It was watched that with the increments in compaction load there is a superior bonding between the joints. Microstructures did not demonstrate any vicinity of Intermetallics. Some dark spot can be watched form the figure 5 it might be porosity it is more conspicuous in the 4 ton sample with the expanding load there is no vicinity dark recognize that has lessened.

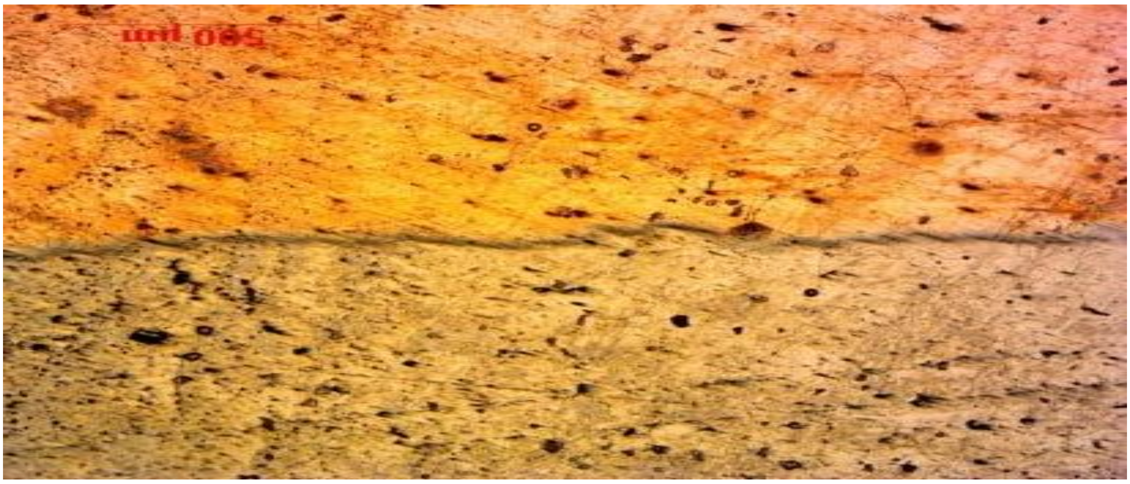

Fig. 3**Optical image of interface between Cu-Fe samples with 4 ton**

Fig. 4Optical image of interface between Cu-Fe sample with 5 ton

Hardness test:

From the hardness graphs of Cu-Fe sample at 4 ton and at 5 ton, it was observed that copper has low hardness contrast with Iron. Form hardness data it was confirmed that there could be a vicinity of Intermetallics because of minor variety found in the hardness at the interface in all the cases. Form the hardness it can be observed that there is a slight variety in hardness of the 6 ton sample this may be because of less porosity.

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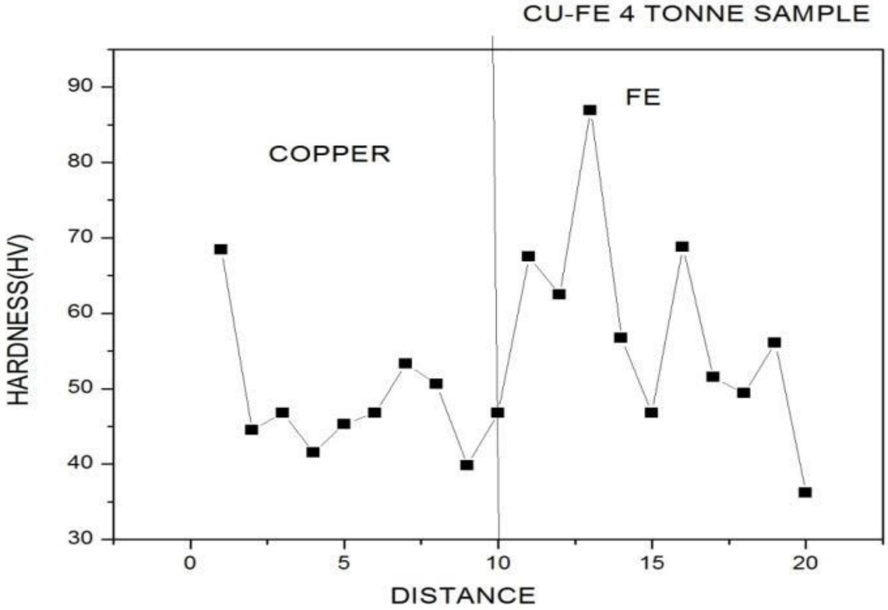
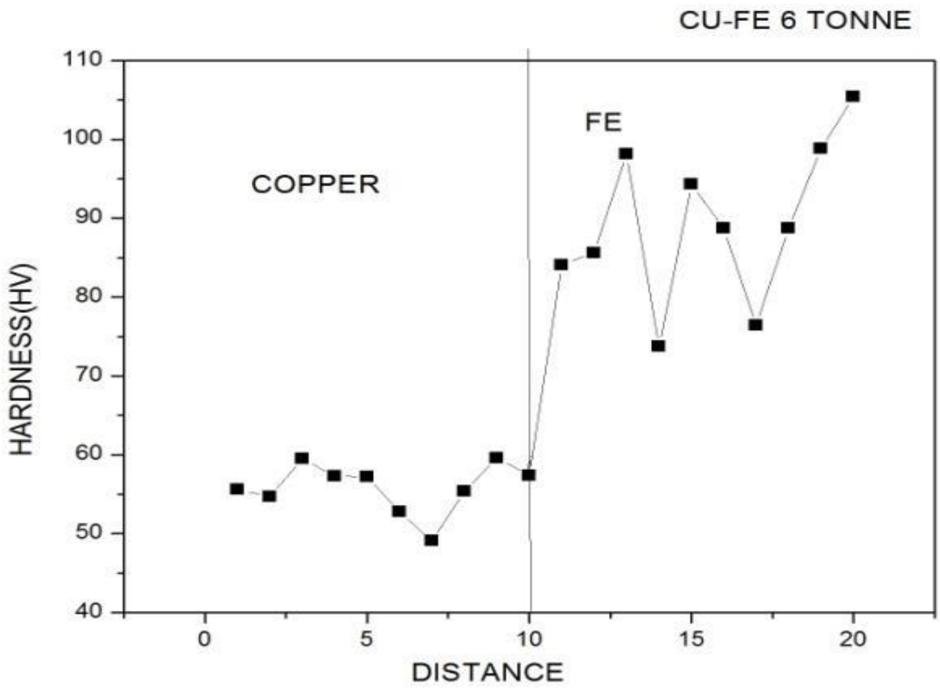


Graph3. Hardness graphs of Cu-Fe sample at 4 ton



Graph4. Hardness graphs of Cu-Fe sample at 6 ton

Compression Test:

From demonstration of the compression test graphs of Cu-Fe sample at 4 ton and 5 ton it was observed that with the expanding the compaction load there is an expanding in the strength of the joint up to 4 ton load however at 5 ton load there is a slight decrease in the strength of the joint.

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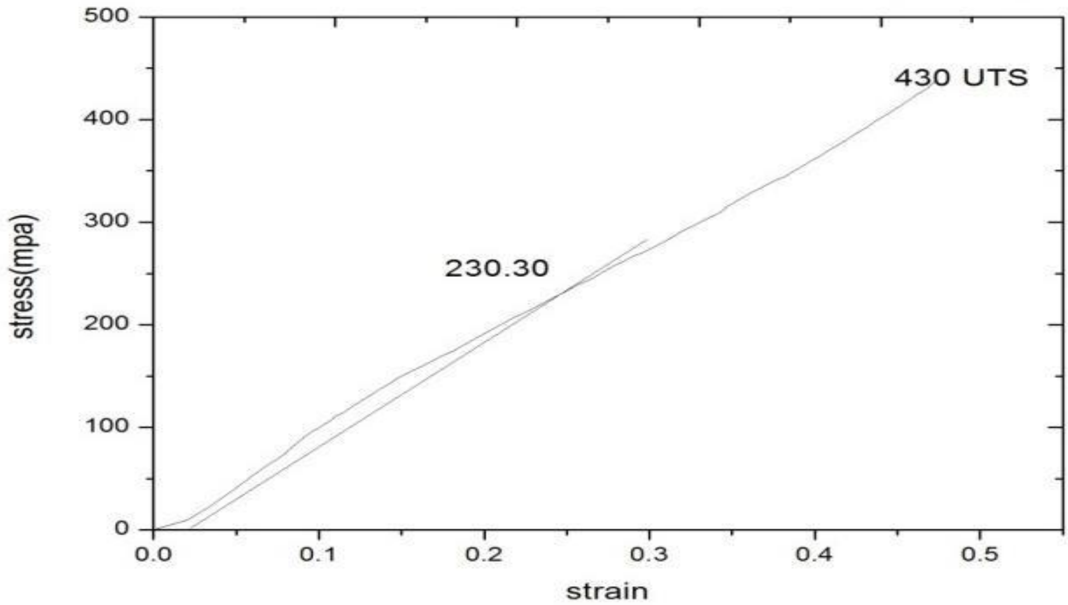
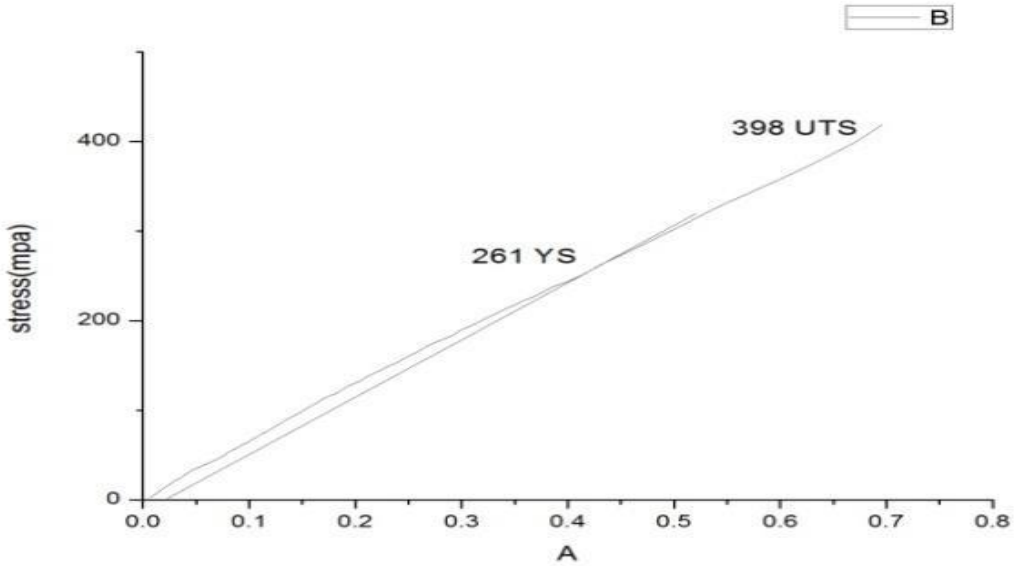


Graph5. Stress strain plot obtained from compression test of Cu-Fe sample at 4 ton



Graph6. Stress strain plot obtained from compression test of Cu-Fe sample at 5 ton

Copper (Cu)-Nickel (Ni)

Optical Micrographs:

Form the figure microstructure it was observed that there is no vicinity of cracks in all the joints. It was watched that with the increments in compaction load there is a superior bonding between the joints. Microstructures did not demonstrate any vicinity of Intermetallics. Some dark spot can be also observed in structure that it might be porosity it is more noticeable in the 4 ton sample with the expanding load there is no vicinity dark detect that has reduced.

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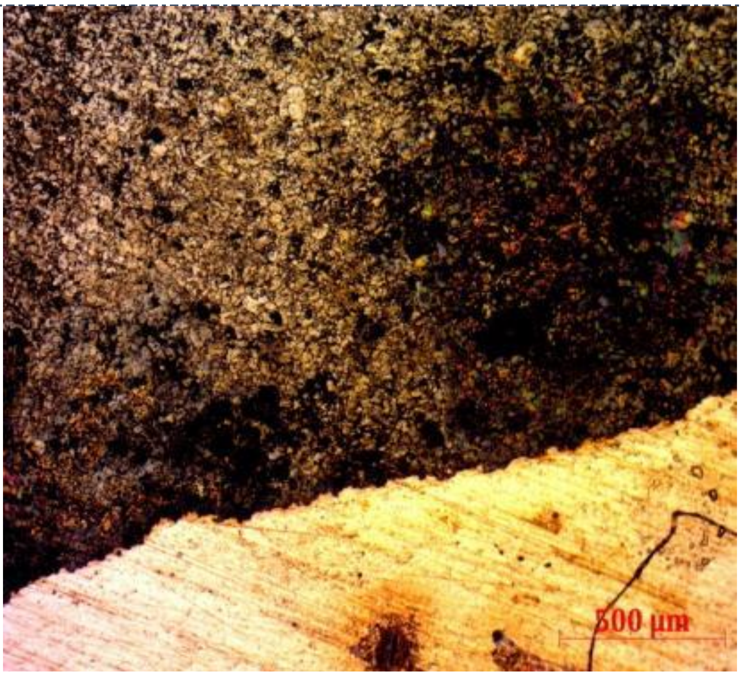

Fig18. Optical image of interface between Cu-Ni sample at 4 ton

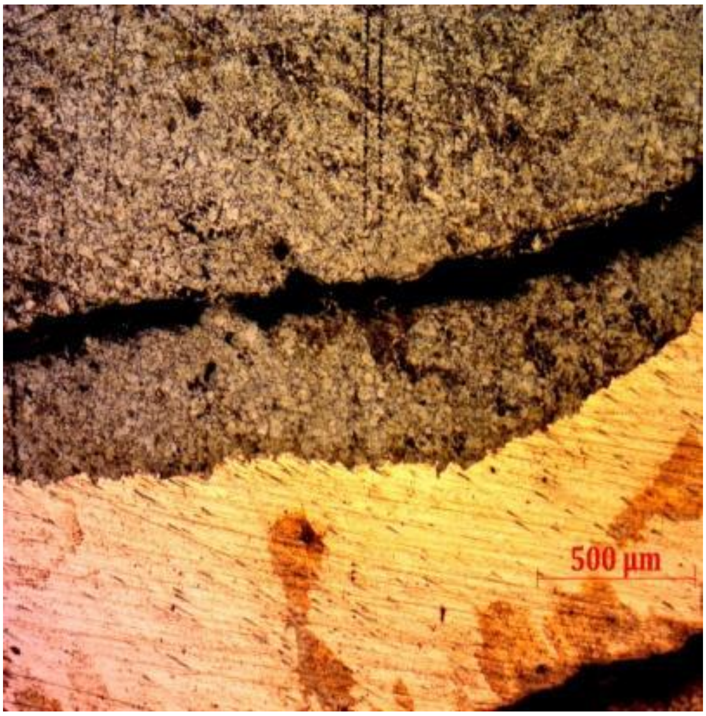

Fig19. Optical image of interface between Cu-Ni sample at 5 ton

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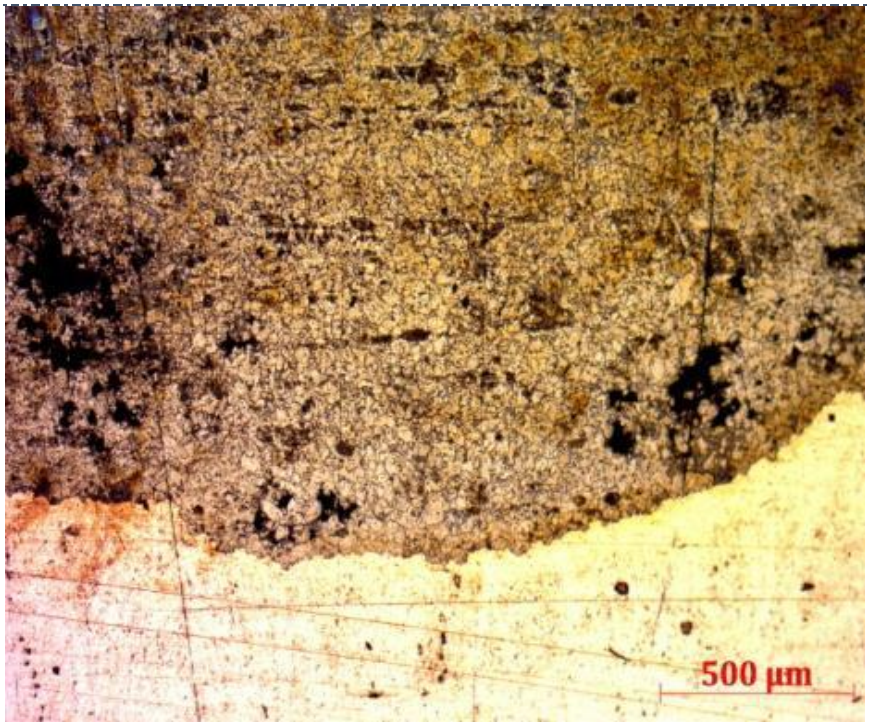
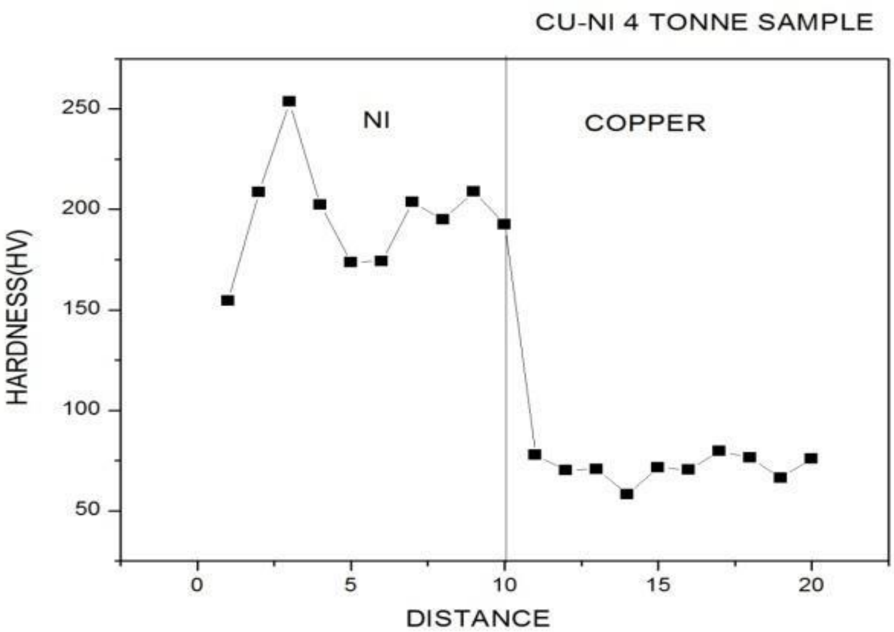


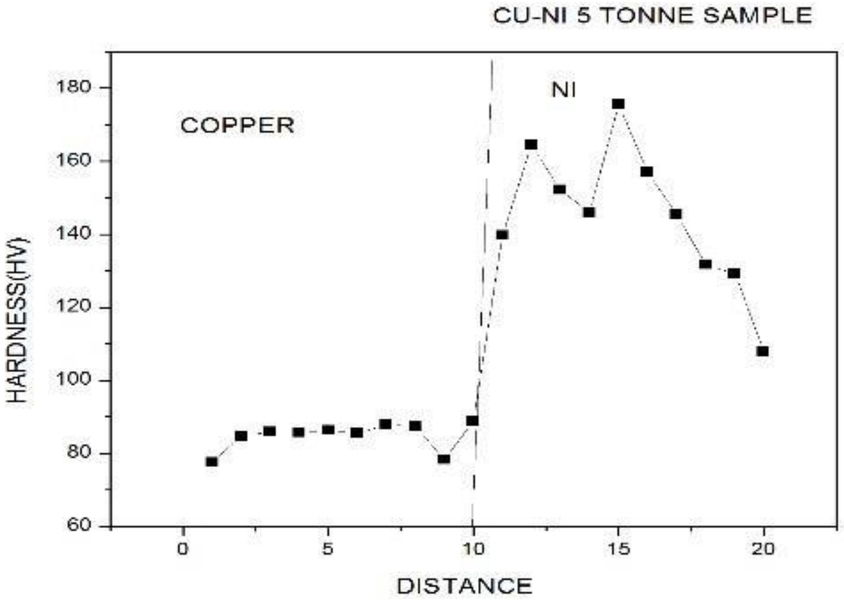
Fig20. Optical image of interface between Cu-Ni sample at 6 ton

Hardness Test:

From the figure of the hardness graphs of Cu-Ni sample at 4 ton and 5 ton, it can be observed that copper has low hardness contrast with nickel. Form hardness data it was confirm that there could be a vicinity of Intermetallics because of marginal variation in the hardness at the interface in all the cases.



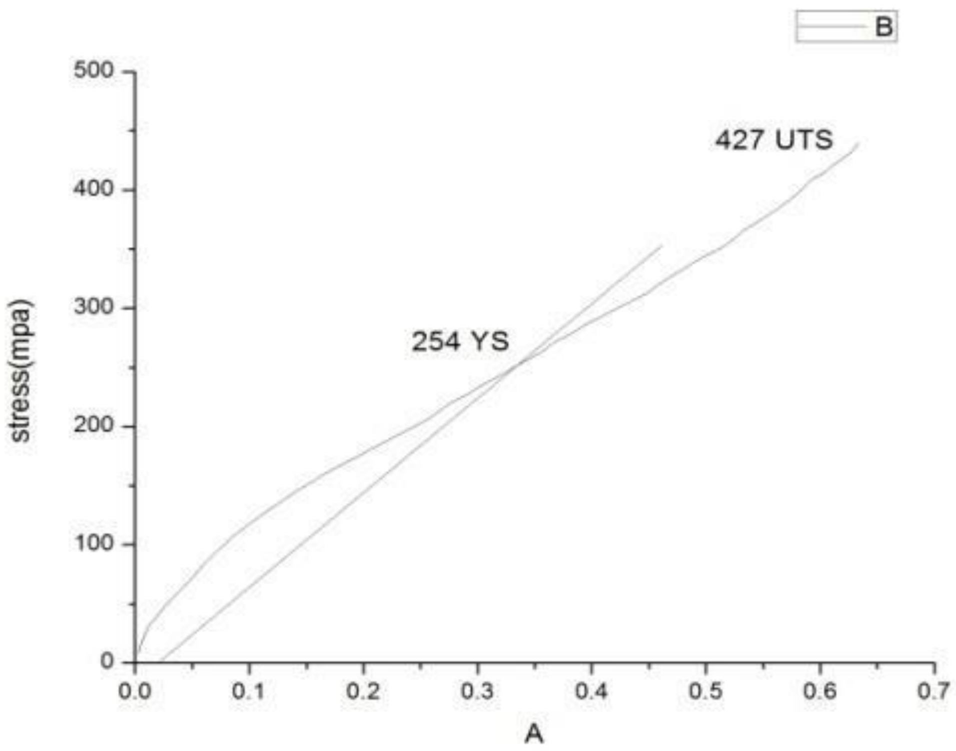
Graph7. Hardness graphs of Cu-Ni sample at 4 ton



Graph8. Hardness graphs of Cu-Ni sample at 5 ton

Compression Test:

From the figure of the demonstration of the hardness graphs of Cu-Ni sample, it can be observed that with the increasing in the compaction load there is an expanding in the strength of the joint this could be because of better diffusion of Cu in Ni and all the more over at higher compaction load there is better bonding happens.



Graph9. Stress strain plot obtained from compression test of Cu-Ni sample

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Table1: Consolidated compression data of all the joints

Table	CU-FE 5 TONNE	CU-FE 4 TONNE	CU-FE 6 TONNE	CU-NI 4 TONNE	CU-NI 5 TONNE	CU-NI 6 TONNE
UTS	430	183.5	398	569	427	526
YS	230.30	172.2	261	258	254	327

V. CONCLUSIONS

- Porosity is not visible from optical micrographs.
- Good bonding is watched from the optical micrographs
- There is no break arrangement in the intermetallic region.
- Cu-SS has indicated enhanced mechanical properties of the joints.

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