# Summer Internship 2016

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## A study on the high temperature metal composites of Iron and Aluminium with Graphene Oxide

TATA STEEL

Carried out @ Tata Steel, Jamshedp

And Tata Labs in CSIR, Bhubaneshv

# ACKNOWLEDGEMENT

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I am also thankful to Dr. Tapan Kumar Rout for given me an excellent opportunity to work at CSIR-IMMT Bhubaneshwar.

Abhijeet Singh

# INTRODUCTION

Given the global demand for novel materials metal composites form an integral part of new age materials, and their application can immense representing the properties of the materials they correspond.

**Motivation**

There is an urgent need to look for new metal composites which will greatly enhance the properties and usability of the metals produced in the iron and steel industry, which can suit the applications of future like space travel, Robotics, heavy machinery, etc.

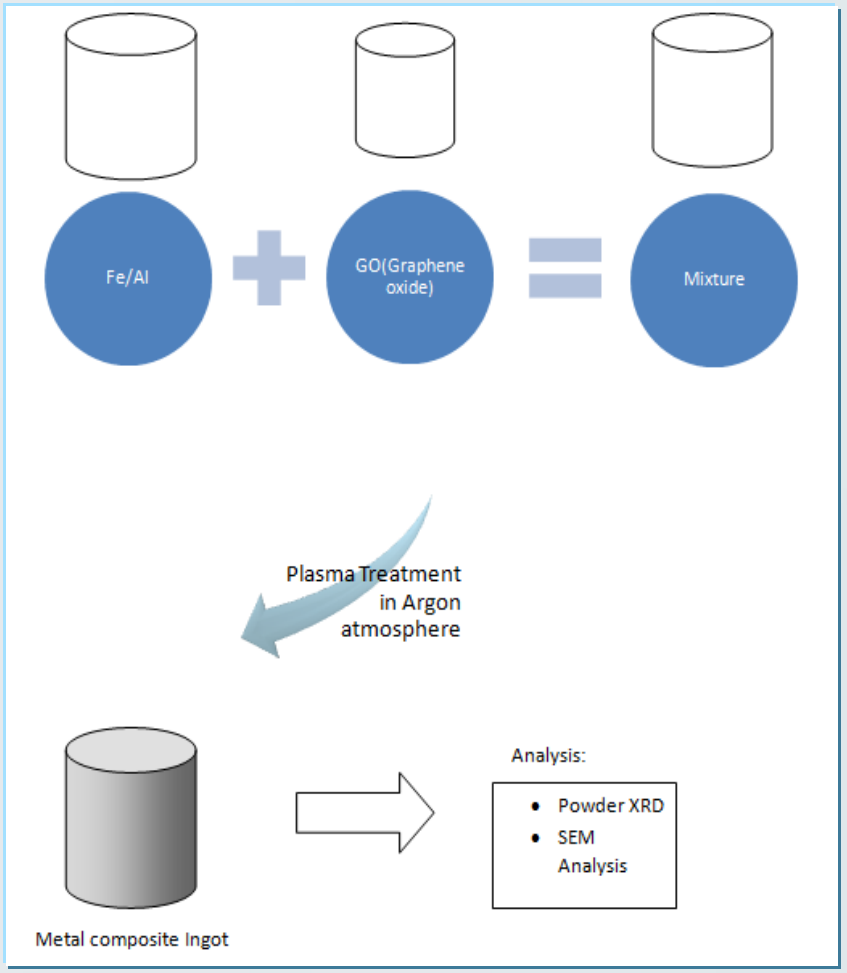
**Abstract**

Graphene oxide can be a great complimentary for the metal composite, due to its several properties like high conductivity , high temperature withstanding capacity, high tensile strength, and a high surface to volume ration making it super light and durable and fit for many industrial as well aeronautical purposes. It is carbon composed so, great pathocidal properties and can be produced in bulk for industrial applications.

**Problem Statement: To** search for new composites of Iron and Aluminum that have enhanced properties of Corrosion resistance, high temperature stability and Tensile Strength and easily reproducible in bulk with sufficient economic feasibility.

# EXPERIMENTAL PLAN

- Mix approx. 200 grams of powdered Al/Fe with 0.5 and 1 percent of freshly prepared graphene oxide (Considering two cases)
- Do the Plasma treatment of the mixture in an Argon atmosphere
- Obtain the metal composite ingot and do the thorough Analysis of it (SEM,Powder XRD,Ultimate-Tensile-Strength(UTS),Micro Tensile Strength(MTS) )



# INSTRUMENTATION

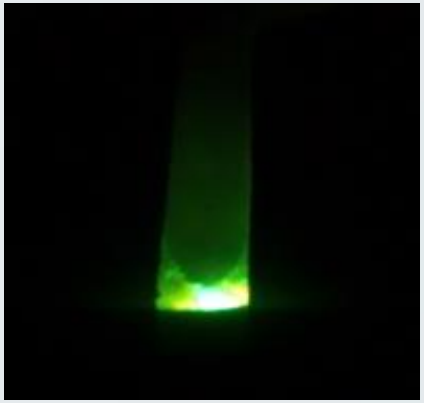
## PLASMA REACTOR

•There were two options available with us for the melting the mixture, one of such was **Plasma reactor** and other being **Furnace**. We chose the former because of the following reasons:

• Plasma Reactor has a advantage of time, it is fast.

• The conditions are very precisely controlled depending upon the voltage applied, which is more generalized in case of Furnace where overall temperature of the furnace is observed.

Fig 1: Plasma Reactor

*(clockwise)Fig 1a:Plasma reactor, Fig 1b:Control Panel of the reactor Fig 1c:The plasma treatment operation*

## Fe –0.5

The physical analysis of the ingot led to the following conclusions:

•The material was found to be course metallic initially suggesting that the Carbon was present in the composite.
•The slag got easily separated from the metal composite.


*Fig 2 a:The Fe 0.5 ingot*

## Fe –1.0

The physical analysis of the ingot led to the following conclusions:

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*Fig 2 b:The Fe 1.0 ingot*

## AL –0.5

The physical analysis of the ingot led to the following conclusions:

•The material was found to be course metallic initially suggesting that the Carbon was present in the composite.
•The slag **did not get easily separated** from the metal composite.

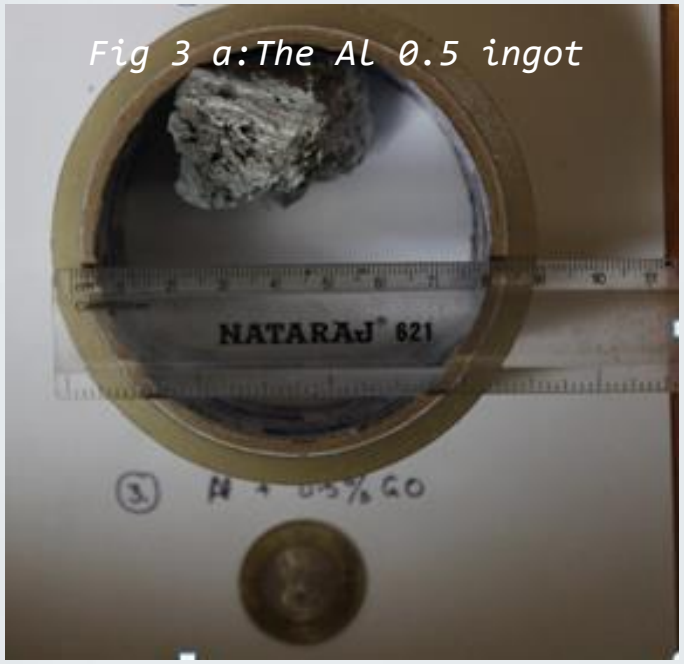


*Fig 3 a:The Al 0.5 ingot*

## AL –1.0

The physical analysis of the ingot led to the following conclusions:

•The material was found to be course metallic initially suggesting that the Carbon was present in the composite.
•The slag **did not get easily separated** from the metal composite.


*Fig 3 b:The Al 1.0 ingot*

# XRD Analysis

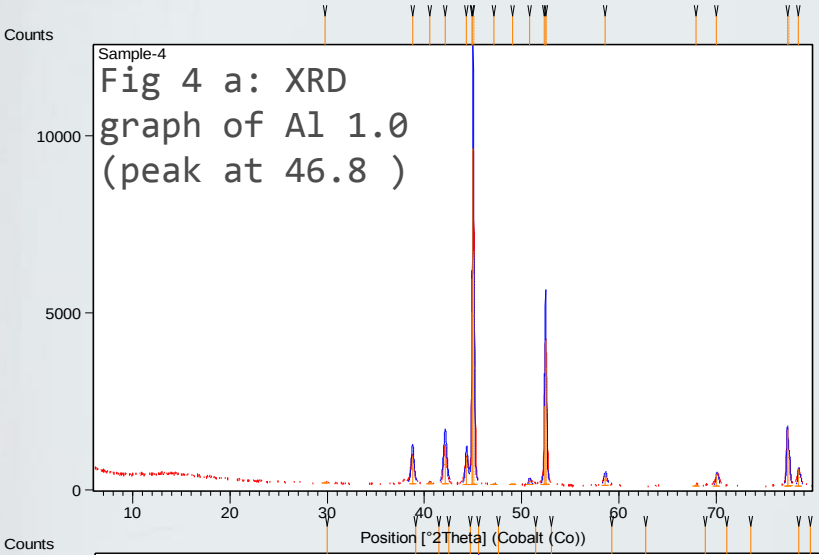


Fig 4 a: XRD graph of Al 1.0 (peak at 46.8 )

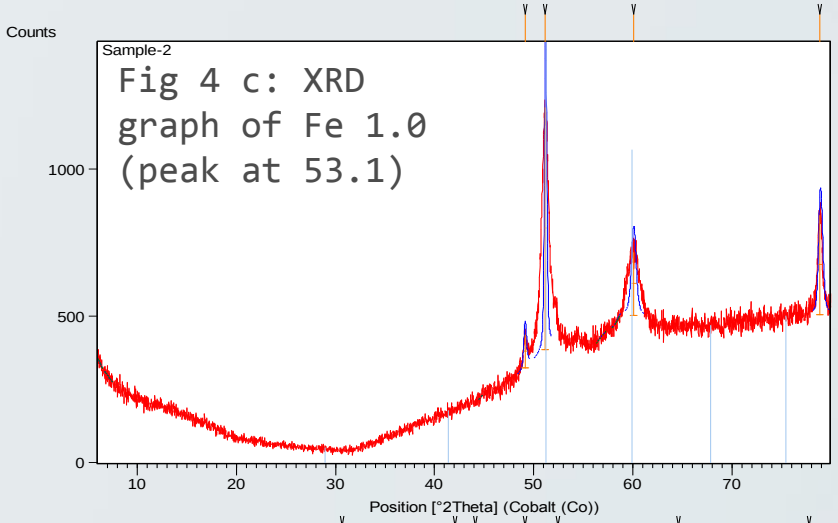


Fig 4 c: XRD graph of Fe 1.0 (peak at 53.1)

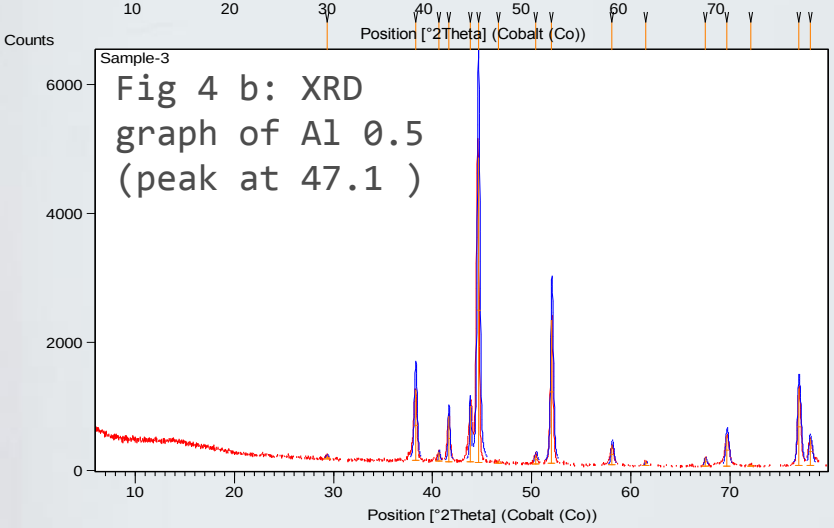


Fig 4 b: XRD graph of Al 0.5 (peak at 47.1 )

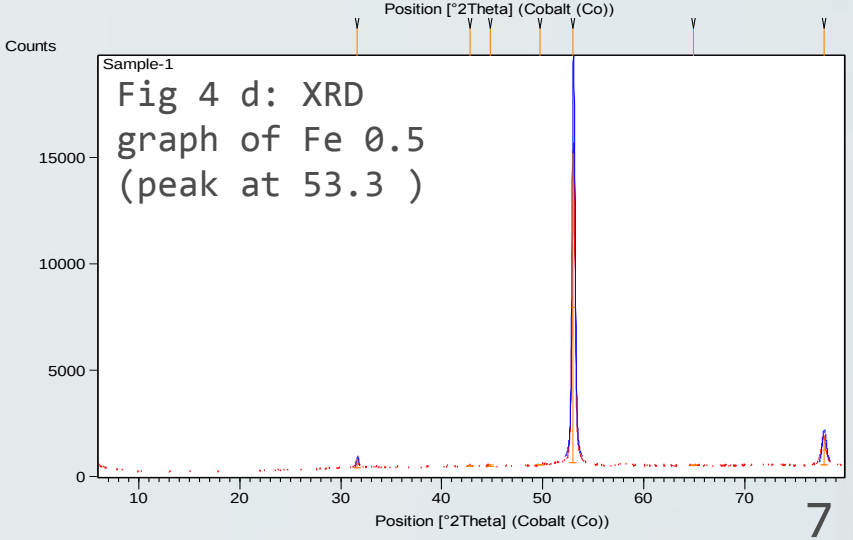


Fig 4 d: XRD graph of Fe 0.5 (peak at 53.3 )

# XRD Analysis –Inferences

**Sample 0.5 Al**

•The Similar kind of graph was obtained as with Fe, the only difference was the intensity of peaks .A common observation

•Although the slag was unable to separate completely from the metal composite which may be the cause for the increased number of peaks than the previous case.

**Sample 1.0 Al**

•Not much difference than the one obtained with the 0.5 percent by weight of Graphene oxide.

•The slag did not get completely separated during the plasma treatment , a reason for the increased number of peaks.

**Sample 0.5 Fe**

•The Sample was found to contain a partial crystalline structure with carbon peak, a prominent feature of the sample.

•The sample composition did not contain slag, which was evident as it got separated during the process of fusion and its subsequent extraction

**Sample 1.0 Fe**

•The Sample was found was found to show prominent characteristics of metal composite involving Carbon, which may be the case because of the presence of the more percentage of Graphene oxide.

•There was also some peaks which were merely because of the presence of different Brag Planes which is an inaccuracy of Powder XRD equipments.

# SEM Analysis (0.5 Fe-1.0 Fe)

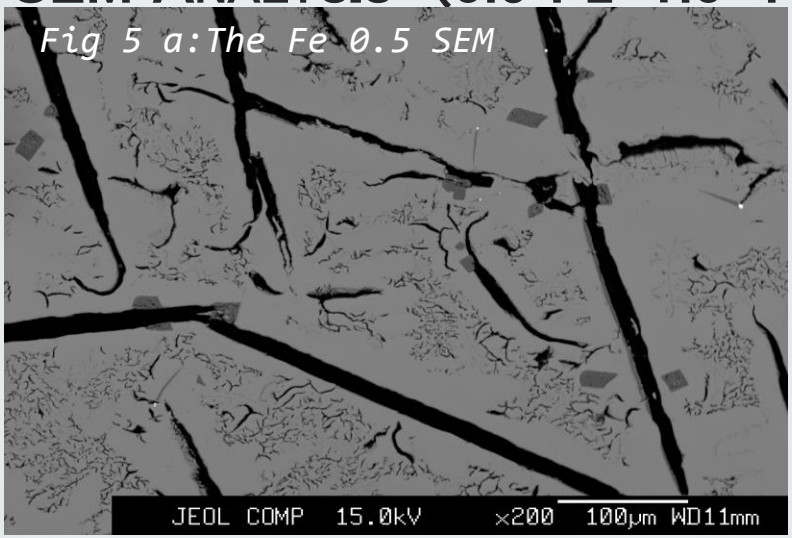


*Fig 5 a:The Fe 0.5 SEM*

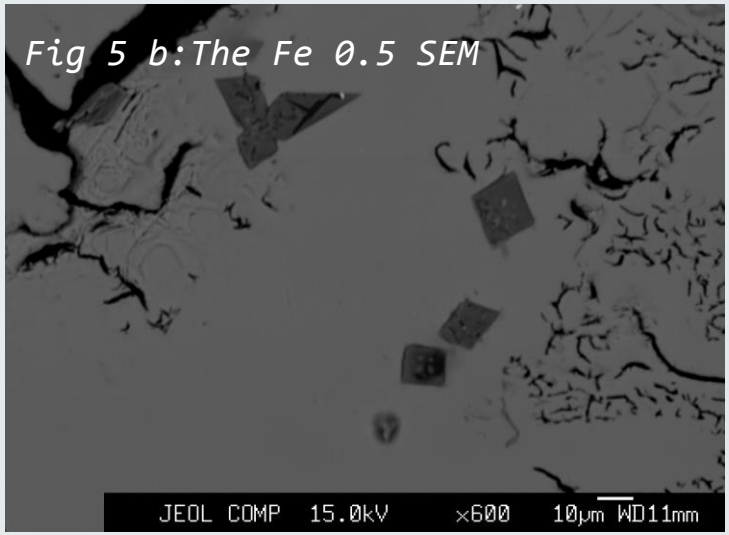


*Fig 5 b:The Fe 0.5 SEM*

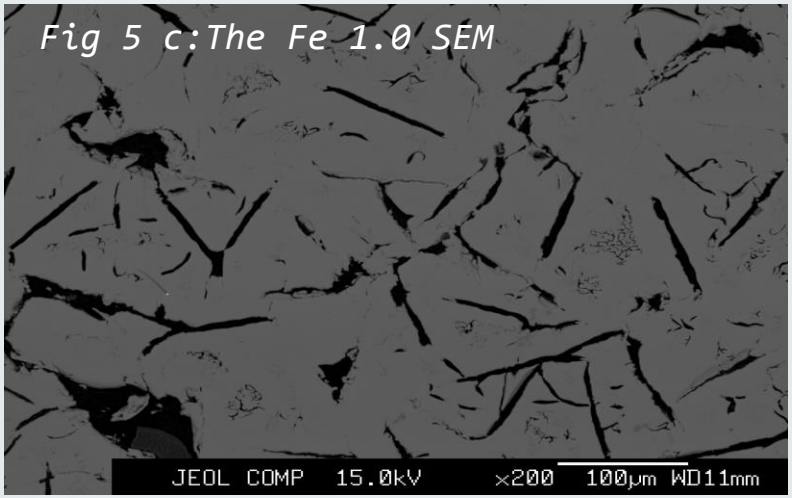


*Fig 5 c:The Fe 1.0 SEM*

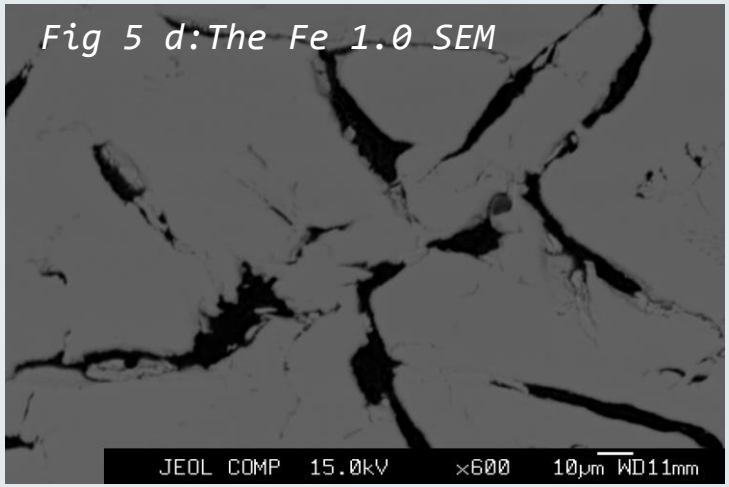


*Fig 5 d:The Fe 1.0 SEM*

# SEM ANALYSIS –INFERENCE

**Sample 0.5 Al**

•The Light and grey patches are again found which is an indication that the Graphite and Graphene have not been lost in the slag and are constantly present in the metal composite matrix.

•There is a presence of unique white dots which is new to this Aluminum sample, reason being unknown.

**Sample 1.0 Al**

• The most detailed structure obtained during the course of the experiment.

•The image clearly shows the presence of light patches in between the metal matrix suggesting the success of our Experiment

**Sample 0.5 Fe**

•The Sample was found to contain light and dark patches which suggest that the metal matrix has some graphene oxide presented in the sample, which imparts a characteristic coarse texture to the sample.

•The darker regions suggest the presence of Graphite , which is non mono-layered a feature which suggest that the sample was not pure graphene oxide.”TRUE”

**Sample 1.0 Fe**

•The Sample was found to contain graphene oxide not easily detected, but evidently present

•The Graphite was located in layered structures in straight lines , an indication of the graphite being present.

# SEM Analysis (0.5 Al-1.0 Al)

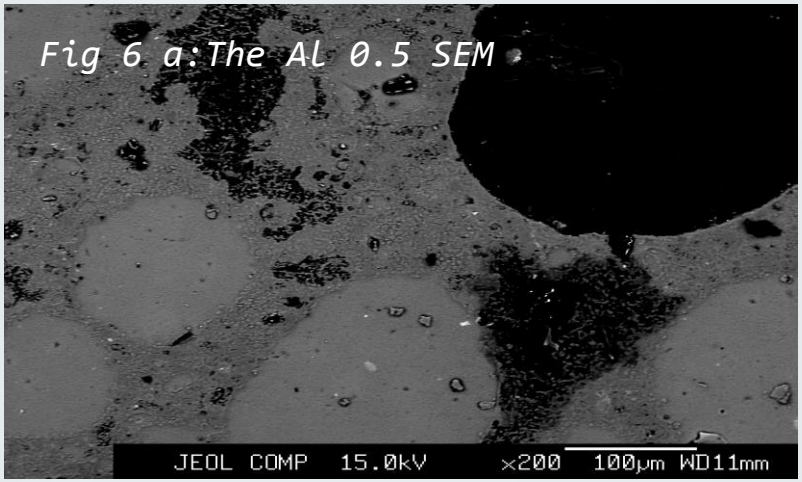


Fig 6 a:The Al 0.5 SEM

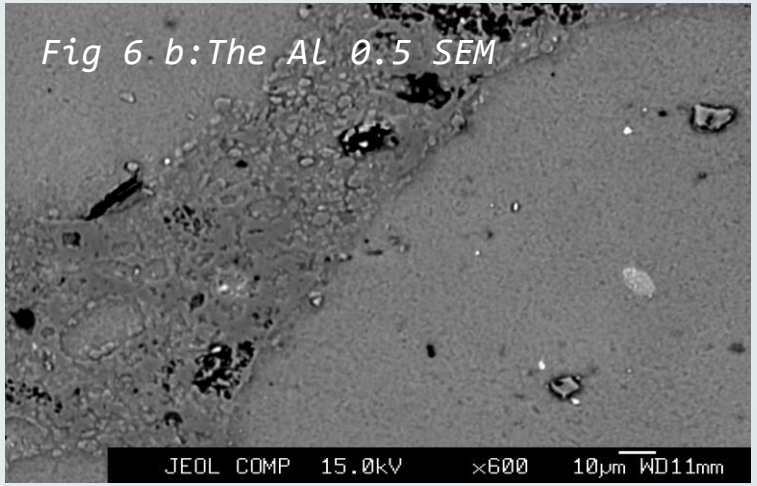


Fig 6 b:The Al 0.5 SEM

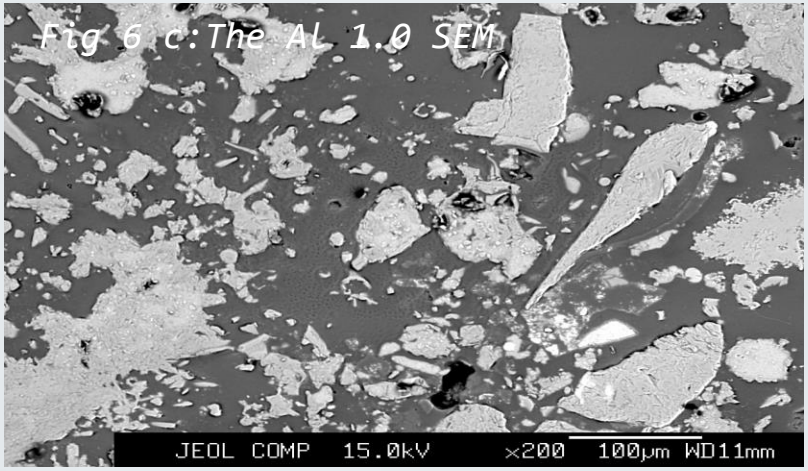


Fig 6 c:The Al 1.0 SEM

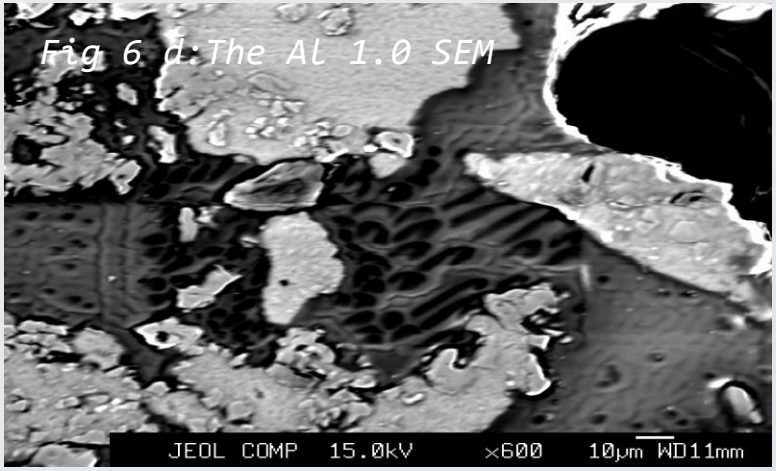


Fig 6 d:The Al 1.0 SEM

# Conclusion

The experiment was a success considering the amount of future work that it will lead to.
There were other tests that are needed to be performed on the samples like UTS(Ultimate Tensile Strength), MTS(Micro Tensile Strength) which will determine the fate of this experiment in totality.
The thermal and electrical conducting properties of these samples need to be further studied to know other properties that are associated with such kind of samples.
The experiment in all its entirety was a success, suggesting that metal composites of Aluminum and Iron are possible with graphene oxide which can yield better properties than their base metals.