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Investigate the Behavior of Carbon Percentage and Sintering Temperature on Microstructure and Densification Parameter of Iron-Based Powder Preform

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Abstract

In this present work effect of temperature and graphite contents on the microstructural and mechanical properties of iron based powder metallurgy freeform was studied. The different graphite (carbon 98

Index terms— iron powder, graphite contents, microstructure and powder metallurgy.

1 Introduction

owder compaction is a popular route for the production of light engineering components such as automotive parts. A common production process consists of cold compaction in a closed-die or in an isostatic press followed by sintering. Most of the densification takes place in the cold compaction step by rate-independent plasticity. Sintering of iron powder with graphite, iron powder with copper and graphite, iron powder with nickel and graphite, iron powder with phosphorus, and iron powder with boron was studied by Narasimhan (2001). Deng, X. Piotrowski, G. Chawla, N. Narasimhan(2008) investigate relationship between microstructure and fatigue crack growth in detail. The density, matrix microstructure, and the degree of pore clustering had a significant effect on the crack growth,describe and explain the fatigue behavior of the steels. A method of making iron-carbon materials in order to obtain materials with a low content of impurities (especially oxygen) and sufficiently high density was developed by **??**ostikov et al. (2008) Carbon in small quantities is added to iron, 'Steel' is obtained. Since the influence of carbon on mechanical properties of iron is much larger than other alloying elements. The atomic diameter of carbon is less than the interstices between iron atoms and the carbon goes into solid solution of iron. As carbon dissolves in the interstices, it distorts the original crystal lattice of iron.

This mechanical distortion of crystal lattice interferes with the external applied strain to the crystal lattice, by mechanically blocking the dislocation of the crystal lattices. In other words, they provide mechanical strength. Obviously adding more and more carbon to iron (up to solubility of iron) results in more and more distortion of the crystal lattices and hence provides increased mechanical strength. However, solubility of more carbon influences negatively with another important property of iron called the 'ductility' (ability of iron to undergo large plastic deformation). The a-iron or ferrite is very soft and it flows plastically. Hence we see P that when more carbon is added, enhanced mechanical strength is obtained, but ductility is reduced. Increase in carbon content is not the only way, and certainly not the desirable way to get increased strength of steels. More amount of carbon causes problems during the welding process. We will see later, how both mechanical strength and ductility of steel could be improved even with low carbon content. The iron-carbon equilibrium diagram is a plot of transformation of iron with respect to carbon content and temperature. Iron-carbon ability in powder metallurgy not such developed and structural properties need to explore.

2 II.

3 Materials Preparation

In order to obtain iron-based powder metallurgy specimens and study the effects of graphite content and temperature on its microstructure properties, the iron powder and the graphite powder purchased from Qualikems Fine Chem PVT. LTD, Vadodara, Gujarat. Four groups of 16g of iron and graphite powder were stirred well and mixed uniformly. Then, four groups of powder mixture were produced and their graphite contents were 0%, 2%, 5% and 10%, respectively. These powder mixtures were used to make compact specimen in the experiments.

4 III.

5 Powder Blending and Mixing

? Taking fine particles powder of iron and other additive then mixing process in involvement of binder to for primarily joining.

? Graphite used as binder for iron/steel powder. This is done through an annealing process where the bonding between particles is caused by diffusion. ? Add lubricants (<5%), such as graphite and stearic acid, to improve the flow characteristics and compressibility of mixtures. ? Air or inert gases to avoid oxidation Liquids for better mixing, elimination of dusts and reduced explosion hazards.

IV.

6 Sample Preparation a) Powder Compaction

A cylindrical die with a diameter of 12 mm was adopted to compact the powder. The cotton with graphite used to wipe and clean the mold wall. Powder mixture of 16 g of weight is taken and put into the die. A UTM (ultimate tensile machine) hydraulic press is used to compact the powder and the load put on the die is 100Kilonewtonand the holding time is 15 minutes.

Then, the compacted specimen was ejected from the die. The specimens were sintered in a muffle furnace. Every single sample three temperature ranges 700, 850, 1000 degree centigrade, holding time is 20 minutes and cooling with the furnace.

7 c) Finishing Operation

Grinder, Amery paper is use in operation of minimizing mechanical surface damage that must be removed by subsequent polishing operations. The metallographic specimens were polished and then etched by nitric acid and alcohol solution.

V.

8 Experiment a) Microstructure Observation

In this study, both temperature and graphite content were considered as the effective factors on the microstructure properties of the sintered specimen. The specimens were produced at three sintering temperatures, 700°C, 850°C and 1000°C, respectively, and with four graphite contents, 0%, 2%, 5% and 10%, respectively. The polished and etched specimens were examined by scanning electron microscopy (SEM) and The microstructures of the sintered specimens with the graphite content from 0% to 10% were shown in above figures. It can be seen that as the graphite content increases from 0% to 10%, the microstructure of the iron-based powder sintered specimen changes gradually from ferrite (white microstructure) and a small amount of pearlite (black and white lamellar microstructure) to pearlite and a small amount of ferrite. A small amount of cementite (Fe_3C) also appeared in the microstructure when the graphite content increased to 2%. It also can be seen that the austenite grain size increases gradually when the graphite content increases. This is mainly because that the degree of superheat increases as the graphite content increases when the sintering temperature is constant, thus contributing to the growth of austenite grain. In 5% cast iron formed in the sample flakes of graphite formed above the surface, packs of austenite increases as percentage of graphite increases. As percentage increases 2 to 5 % Spheroidal structure increases in images. Then graphite percentage increases 5 to 10% white area increase for ever temperature and packs of austenite escape in images, there is clearly to main surface saw in the images white and other one is black layered and as per temperature increases the white region increases.

Comparing the microstructures of the sintered specimens at 700°C to 1000°C from Image 1 Image 2 and Image 3, it can be concluded that with the sintering temperature increasing, the micro structures of the sintered interface become uniform. This is mainly because of the formation of many meshes of grain boundary and their interactions with the interwoven pores. The excess vacancies at the edge of the sintering neck and on the surface of micro-pores are easy to pass the adjacent grain boundary and diffuse or absorb. The higher the sintering temperature, the greater the coefficient of the atomic diffusion within the particle, and the faster the sintering carried out. When temperature increases graphite given the three form flake, compacted, spheroidal.

9 b) Density

Density of the specimen can be calculated by?? = ?? ?? ?

Where , ?? and ?? is the mass, the volume and the density of the sintered specimen, respectively then?? = ???? 2 ?? 4

Where d, l is diameter and length of the sintered specimen, respectively.

10 So

11 Conclusion

a) As graphite content increases from 0% to 2%, the microstructure of the iron-based powder sintered specimen changes gradually from ferrite and a small amount of pearlite to pearlite and a small amount of ferrite. After 2% of graphite contents the microstructure was found pearlite and ferrite. As graphite increase up to 5% gray cast iron structure and at 1000? C temperature range white cast iron structure found on the surfaces. b) After 5% of graphite contents ferrite and cementite microstructure observed. White cast iron formed around 8% of graphite contents and free carbon particles seen on the surfaces. c) The BCC structural ferrite properties shown in 700?

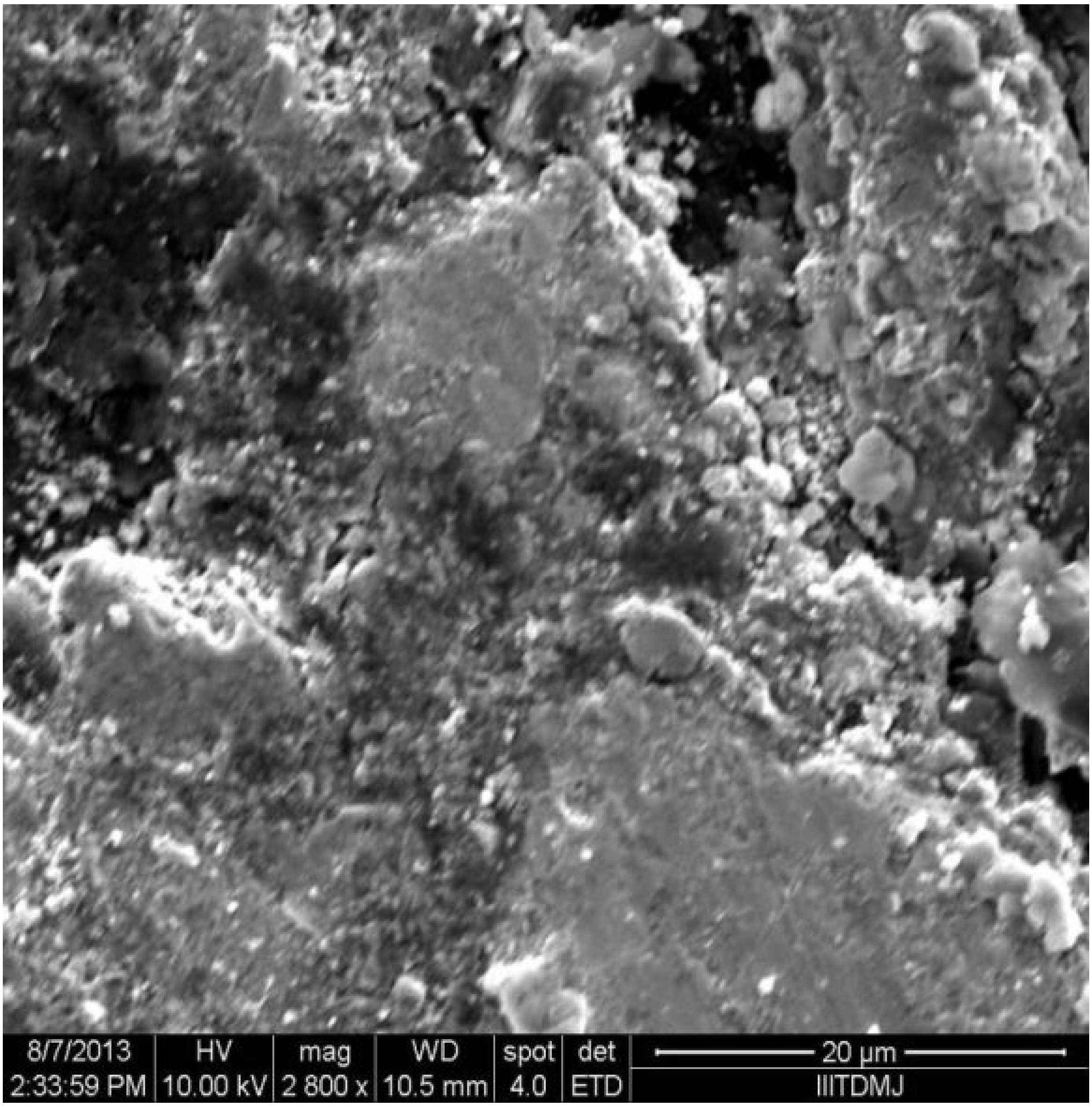
and FCC structure austenite form in 1000?. d) The austenite grain size increases gradually when the graphite content increases. e) The maximum value of density was found maximum between the range 2% to 5% of graphite contents. f) Maximum density was found at the temperature 850?C Sintering temperature range 700,850 and 1000? best result finding at 850? and followed by 700?C and 1000?C. [1]

1

Figure 1: Figure 1 :

123

Figure 2: Image 1 :Image 2 :Image 3 :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HV
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mag
2 800 x
WD
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spot
4.0
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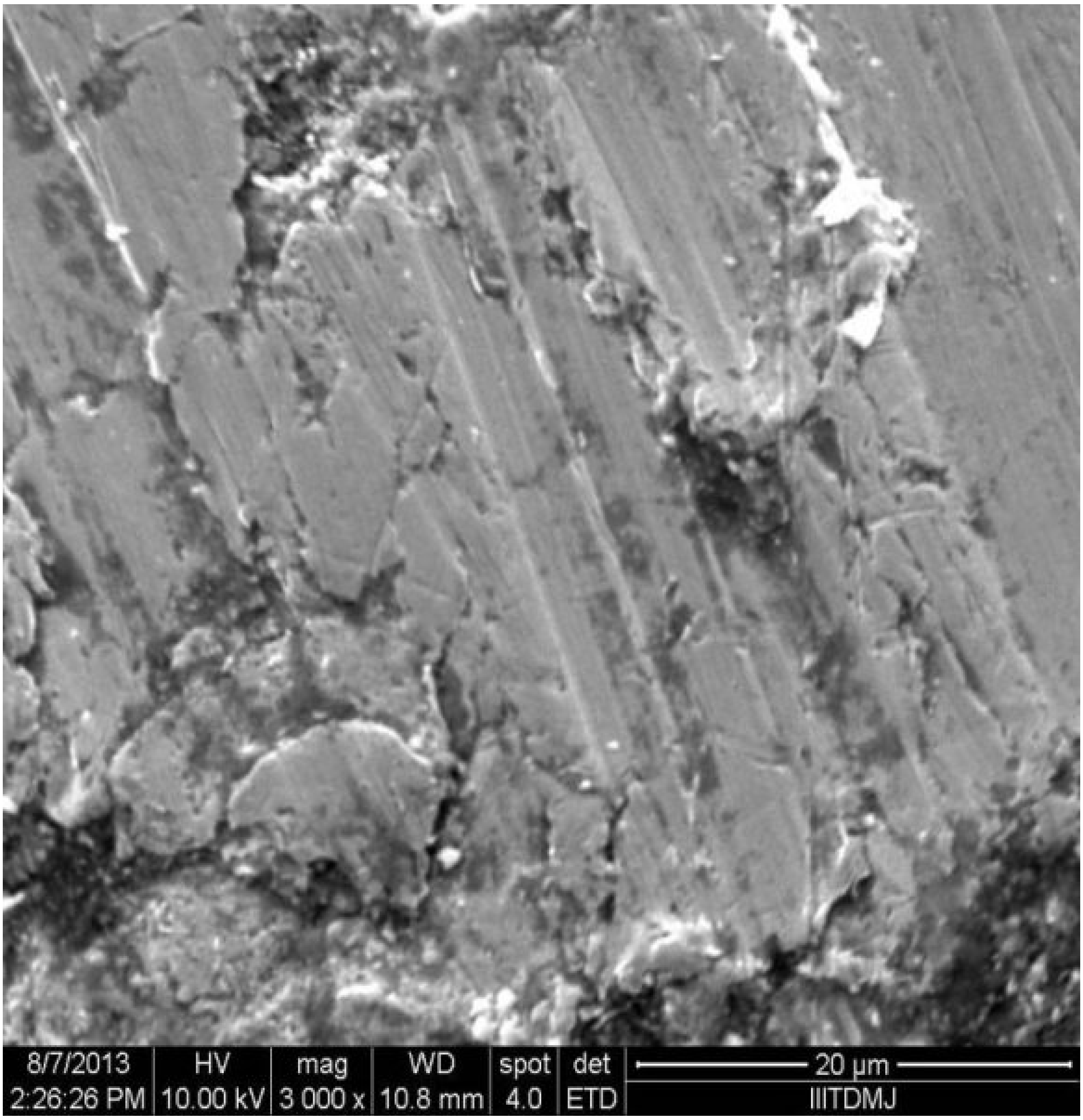
ETD
20 μm
IIITDMJ

Figure 3: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IIITDMJ

Figure 4:

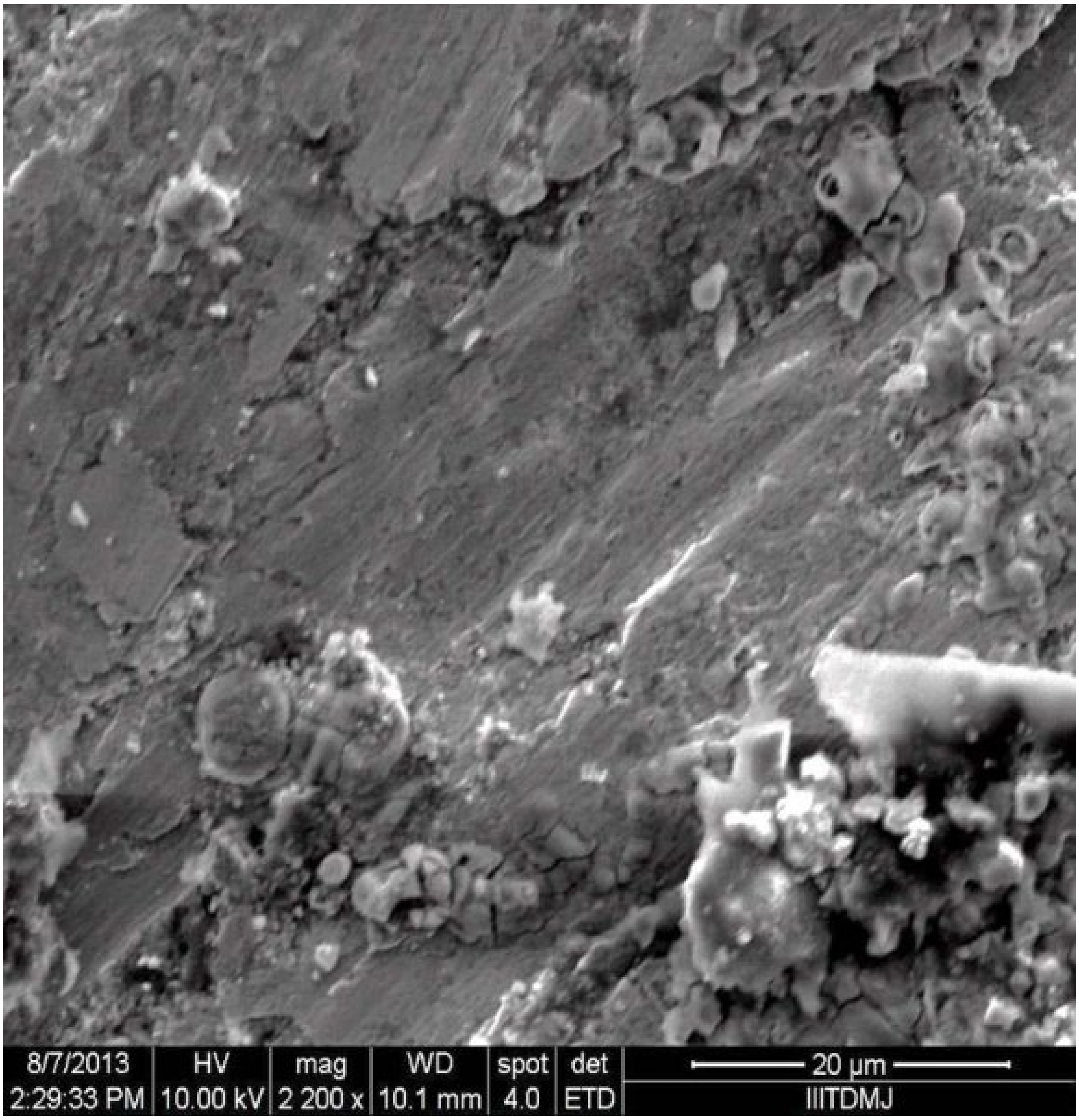
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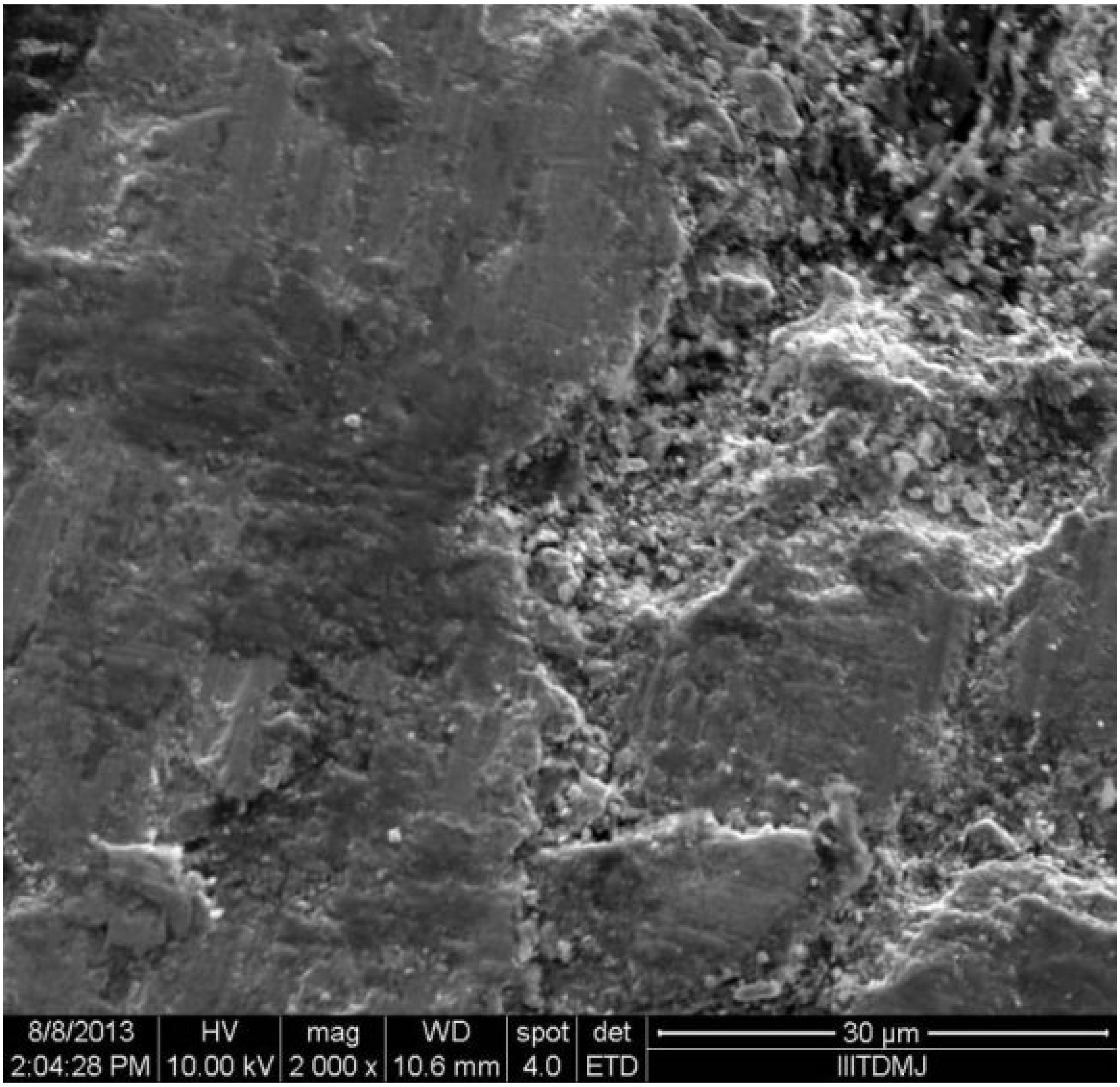
Figure 5: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mag
2 000 x
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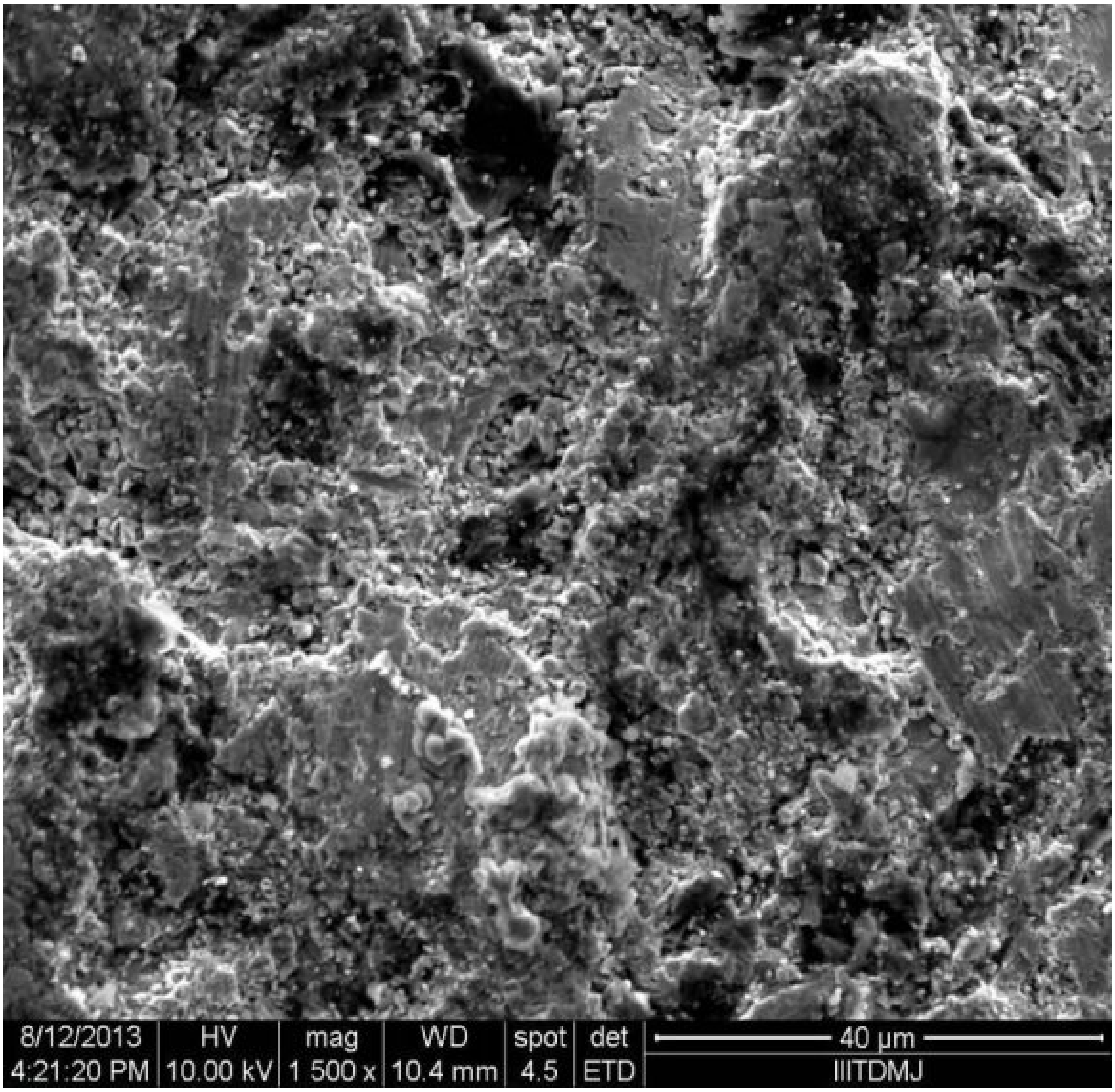
det
ETD
30 µm
IIITDMJ

Figure 6: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ETD
40 µm
IIITDMJ

Figure 7:

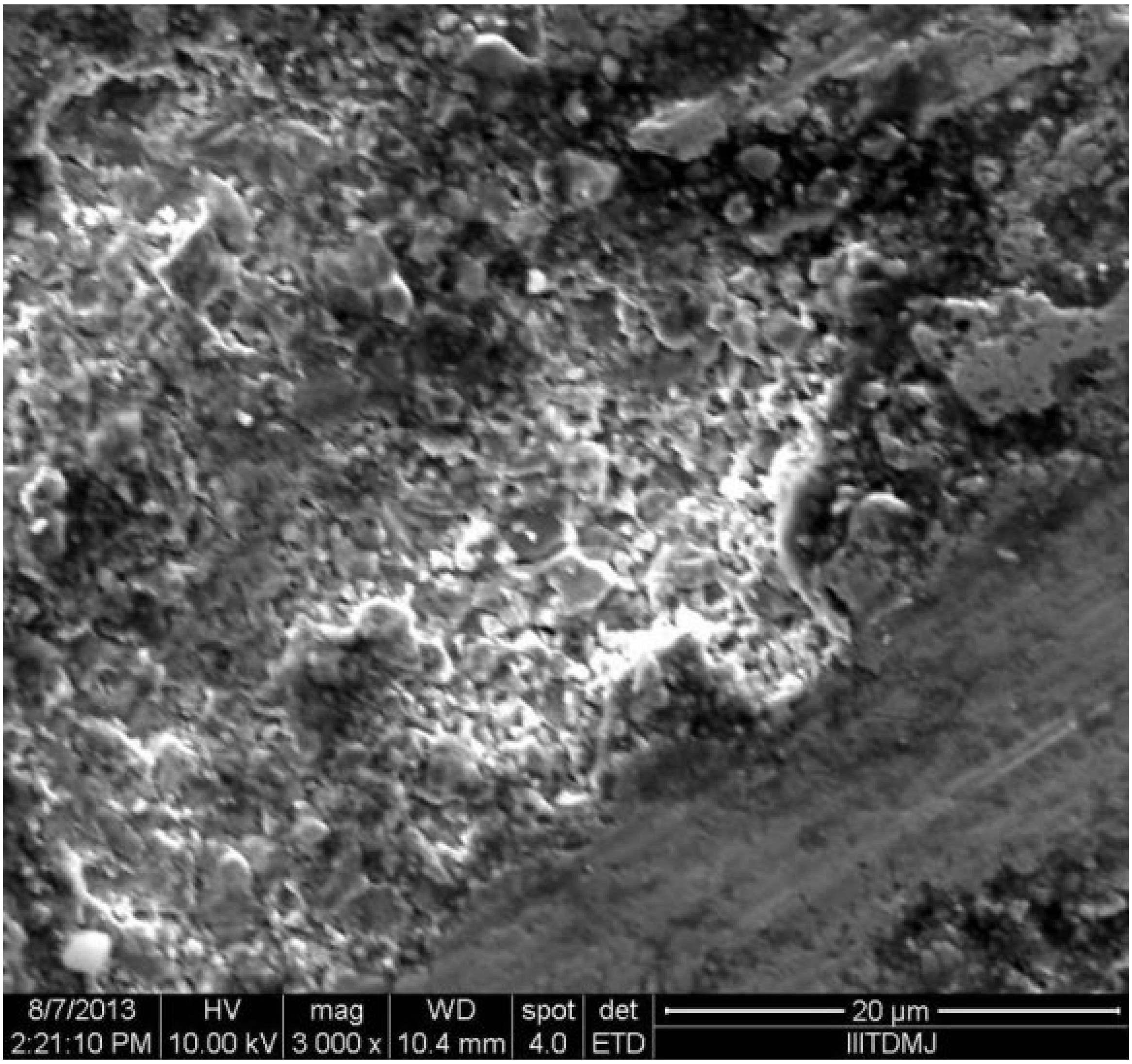
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Figure 8:

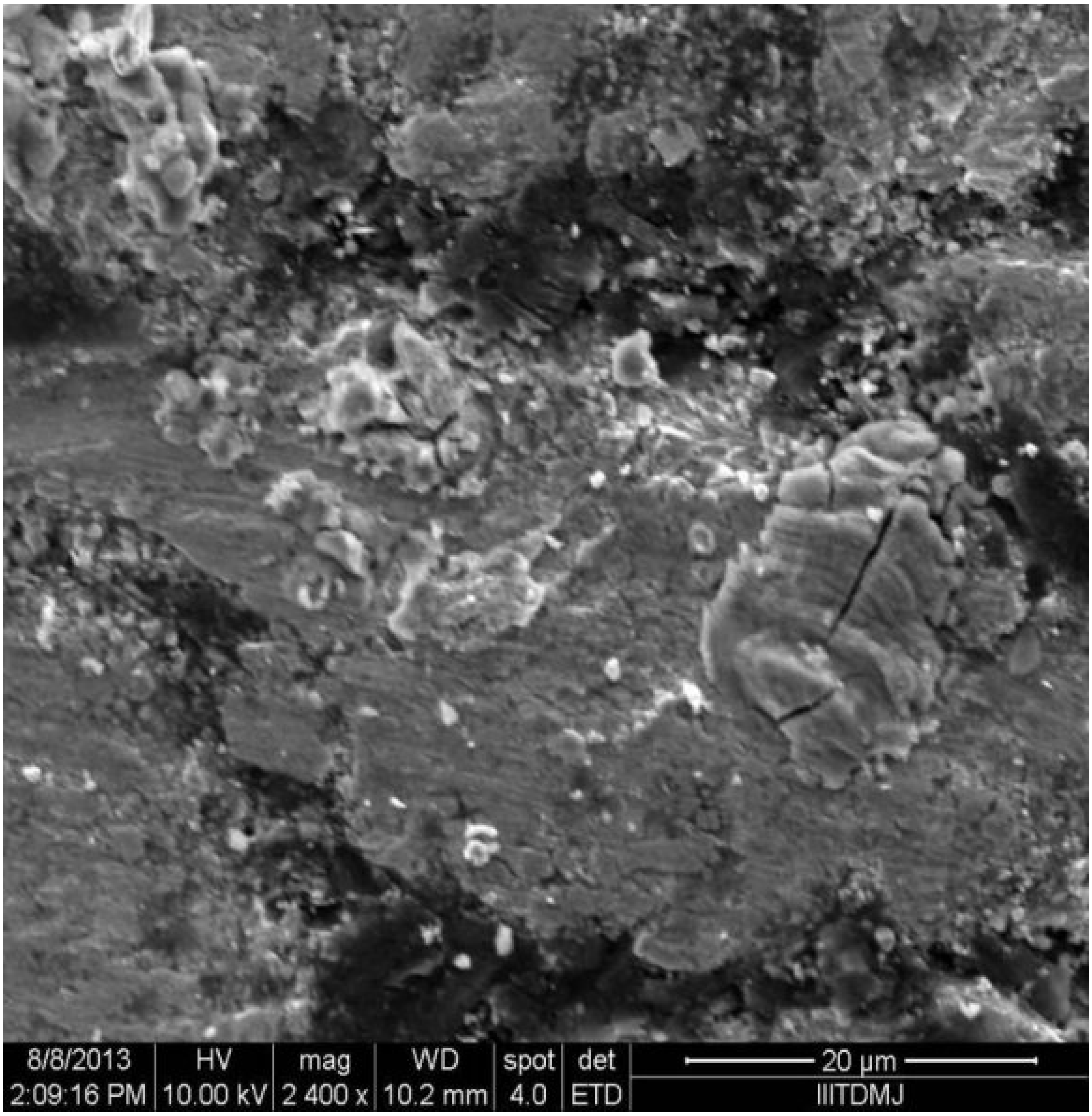
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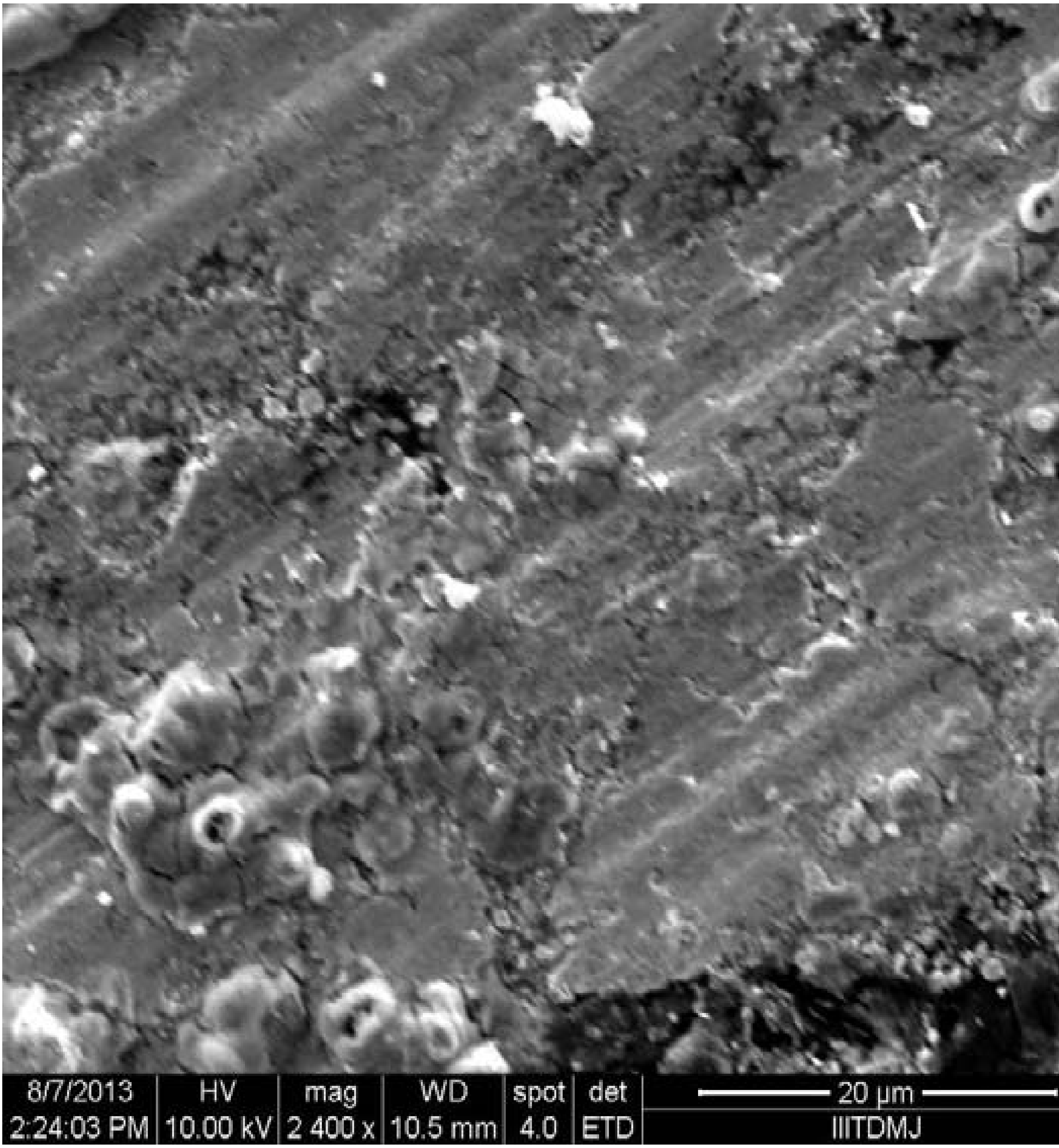
Figure 9: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ETD
20 µm
IIITDMJ

Figure 10:

Xiaoxun Zhang, Fang Ma, Kai Ma & Xia Li in (2012) giving behavior of Graphite Content on various Temperatureand effect on Microstructure and Mechanical Properties by iron based Powder Metallurgy Parts. ChandanaPriyadarshiniSamal, at el reported in (2012) about Microstructure and Mechanical Property Study of Cu-graphite Metal Matrix Composite Prepared by Powder Metallurgy Route. S.B. Halesh, P. Dinesh in 2013 (International Journal of Engineering and Innovative Technology) investigate about Development of Sintered Iron Based Ternary Alloy for Wear Resistant Applications.

Figure 11:

[Norazianaparimin ()] ‘A STUDY OF MICROSTRUCTURE AND HARDNESS ON Fe-Co/SiC Composites’. A L Norazianaparimin . *NUCLEAR and Related TECHNOLOGIES* 2009.

[Components and Handbook] H H Components , Handbook . *Hoganas publication*,

[Verma and anand ()] *Effect of Carbon Addition and Sintering Temperatures on Densification and Microstructural Evolution of Sinter-Hardening alloy steel*, N Verma , S &anand . 2007.

[Zhang ()] ‘Effects of Graphite Content and Temperature on Microstructure and Mechanical Properties of Iron-Based Powder Metallurgy Parts’. Xiaoxun Zhang , FM . *Materials Science Research* 2012. p. 7.

[Deng et al. ()] ‘Fatigue crack growth behavior of hybrid and prealloyed sintered steels’. X Deng , G Piotrowski , N Chawla . *K.S. Materials Science & Engineering* 2008.

[Salak ()] *Ferrous Powder Metallurg. Cambridge UK: Cambridge Int*, A Salak . 1995. Sci. Pub.

[Herbert Danninger ()] *IRON-CARBON MASTERALLOY -A PROMISING APPROACH FOR INTRODUCING CARBON INTO HIGH DENSITY SINTERED*, C G Herbert Danninger . 2011.

[Dieter] *Mechanical metallurgy*, E Dieter , G . McGraw-Hill.

[Upadhyaya ()] *Powder metallurgy technology. CAMBRIDGE INTERNATIONAL SCIENCE PUBLISHING*, S Upadhyaya , G . 2002.

[Alkan ()] *PRODUCTION AND ASSESMENT OF COMPACTED GRAPHITE IRON DIESEL ENGINE BLOCKS*, A Alkan . 2011.

[Dautzenberg ()] *Reaction Kinetics during Sintering of Mixed Alloyed Steels of and Graphite Powders*, N Dautzenberg , J . 1977.

[Sabagh ()] *The Effect of Compacted Graphite Iron Microstructure on Fracture and Machining*, Mohammed El Sabagh , WM . 2011.