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EXPERIMENTAL INVESTIGATION OF CAST IRON AND ITS DEFECTS

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ABSTRACT

An investigation was carried out to examine the influence of cryogenic treatment on the microstructure as well as the thermal and electrical properties of gray cast iron. The microstructure was characterized using optical and SEM microscopy, X-Ray Diffraction, and TEM analysis. The results of this investigation indicate that cryogenic treatment does not significantly change the observable microstructure but does enhance the electrical and thermal properties of gray cast iron. A mechanism based upon the decomposition of cementite at cryogenic temperatures is hypothesized to explain these property improvements.

1. INTRODUCTION

Cast iron castings are revolutionary materials called metal foams, exhibit different attractive characteristics when compared to their solid material counterparts (John Banhart 2000). The strong and stiff materials can be found in nature but they usually do not induce any recycling and pollution problems. Therefore, it is a very good guide for the prospective development of new materials. The difference between strong, natural and artificial materials has been very well characterized by Ashby et al (2000). According to Khayargoli et al (2004) cast iron structures are cellular materials that have great strength-to-weight ratio and are used for applications in mechanical, chemical and medical fields. When modern man builds large load-bearing structures, thus people make use of dense solids like steel, concrete, glass. Nature does the same, with the cellular materials like wood, bone and coral. Really, natural materials are strong enough to withstand loads in bones of running elephant or to carry the weight of 100 m high redwood tree. Babcsan et al (2005) reported that cast iron castings are the materials which provide the tool for the realization of optimal combination of properties e.g. highest stiffness at minimum weight. In the past, when a large dense metal contained any kind of pores, it was considered as “defect” and therefore thought unsuitable for engineering 2 purposes. Consequently efforts were made by engineers and scientists to produce a fully dense metal, free from any kind of pores. In recent years a great importance has been attached to a new class of engineering material, known to be “Cast iron structures or metal foams” with unique mechanical and physical properties.

2. LITERATURE REVIEW

Hsu et al. [7] studied the influence of austempering process at different austempering temperatures on the fracture toughness of gray cast iron and compared it with that of the as-cast gray iron. The as-cast material was austenitized at 900ºC for 1.5 hr and then austempered at 300ºC/3 hr or 360ºC/2 hr so as to obtain different matrix morphology, namely, lower ausferrite or upper ausferrite. A mixed ausferrite structure was also achieved by austempering at 360ºC for 8min followed by 300ºC for 172 minutes. They reported that austempering heat treatment applied to gray cast iron greatly improved the SCOPE.

CHARACTERIZATION DETAILS:

The X-ray diffraction (XRD) technique is one of the non-destructive powerful scientific tools for crystal structure determination, phase quantification and phase transfer analysis of crystalline materials.

Unending importance of this technique has vital role in the fields of the materials science, geology, forensic science and bio-medical, etc. this is clear-cut method for understanding nature of the materials. The indexing, structural determination and the phase transformation analysis using powder XRD data is significantly challenging as compared to single crystal XRD methods. Extensive literature is available on XRD studies of high symmetry inorganic metals, alloys, inorganic salt, and hybrid solid materials. However, such studies on aromatic organic molecular materials of significance in optoelectronic devices are less attached may be because of low symmetry and rigorous mathematical calculation data estimation.

Crystalline materials are characterized by the long-range orderly periodic arrangements of atoms

The unit cell is the basic repeating unit that defines the crystal structure.

- The unit cell contains the symmetry elements required to uniquely define the crystal structure.
- The unit cell might contain more than one molecule: For example, the quartz unit cell contains 3 complete molecules of SiO2.
- The crystal system describes the shape of the unit cell
- The lattice parameters describe the size of the unit cell. The unit cell repeats in all dimensions to fill space and produce the macroscopic grains or crystals of the material.

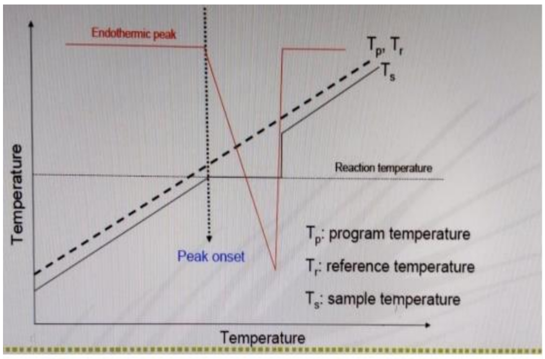
The Diffraction Pattern Is A Product Of The Unique Crystal Structure Of A Material:

The crystal structure describes the atomic arrangement of a material. The crystal structure determines the position and intensity of the diffraction peaks in an X-ray scattering pattern.

- Inter atomic distances determine the positions of the diffraction peaks.
- The atom types and positions determine the diffraction peak intensities.

Diffraction peak widths and shapes are mostly a function of instrument and micro structural parameters.

Thermo gravimetric analysis (TGA):



Thermo gravimetric analysis (TGA) is an evaluation technique that measures different substance masses as their temperature is changed or at a constant temperature over a given time. It is used to analyze decomposition and evaporation rates, oxidation, material purity and many other properties.
A TGA analysis is performed by gradually raising the temperature of a sample in a furnace as its weight is measured on an analytical balance that remains outside of the furnace. In TGA, mass loss is observed if a thermal event involves loss of a volatile component.

TGA Basics:

Measures changes in weight in relation to changes in temperature.The measured weight loss curve gives information on: changes in sample composition.thermal stability.kinetic parameters for chemical reactions in the sample. A derivative weight loss curve can be used to tell the point at which weight loss is most apparent.

Machine will be tested-

Figure shows figure of proposed model.While TG only measures changes caused by mass loss, DTA also

register changes in material where no mass loss occur, e.g. crystal structure changes, melting, glass transition, etc.Carefulness required with performance of the experimental procedure to obtain correct weight loss curves and thermo grams (e.g. sample preparation, choice of crucible, choice of thermal program) Origin of TG-DTA signal good to know for better understanding of measured data.energy. The heat energy transfers to heating panel, heatingpanel is device which converts heat energy to electrical energy. heating panel work only on heat energy or light energy. The generated electrical energy (D.C. current) transferred to storage circuit. By using storage circuit we charge battery and stored electrical energy (D.C.). Connect the load across the battery.

ADVANTAGES:

1) Almost all kinds of samples, conducting and non-conducting (stain coating needed);
2) Based on surface interaction --- no requirement of electron-transparent sample.
3) Imaging at all directions through x-y-z (3D) rotation of sample.

DISADVATAGE:

1) Low resolution, usually above a few tens of nanometers.
2) Usually required surface stain-coating with metals for electron conducting.

3. FUTURE SCOPE

1) Nano-mechanical application is field of micro-electro-mechanical system [MEMS device].

2) Cast Iron (Fe, AlN) can be used in Nano-mechanical device and instruments.

3) Thermally activated instruments can be heat treated with Fe, AlN to improve their performance for stability purpose.

4. CONCLUSION

We have experimentally investigated the sample of cast iron. Following are the test conclusions obtained from the characterization techniques such as XRD, SEM, and DSC-TGA.

Research conclusions are followed by,

1) The crystal structure of Cast iron is alloy, metal which is matched with JCPDS card No.0870721

2) The crystal size of Cast iron nanoparticles was based on the Scherer equation is 32.9nm.

3) Lattice parameters are a= 2.8662, b= 2.8662, c=3.8662, volume of cell is 23.55.

4) Dislocation density is 9.23*10-4 nm, Micro strain is 1.042*10-3.

5) SEM image morphology shows the flasks-like morphology of Cast Iron. 6) DSC-TGA analysis shows stability of material above 8000C.from the experimental investigation test we concluded that the prepared sample of Cast iron can be used for the various Nano-Mechanical applications.

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