Metalurgy lab report assignment

Different kind of sand paper was used to grind and make smooth the spacemen and finally lashing cloth with diamond suspension was used to remove the extra scratch . To differentiate the grain boundaries it was etched by initial solution. Finally the first observation was taken made by optical microscope and scanning electron microscope. Introduction This paper contains some important experiment results concerning metals properties. The main aim of the laboratory experiment was to examine and to compare the macrostructure and hardness of different carbon content metals, starting from 0. %C, 0. 4%C, I. CO% content metals with different heat treatment and cooling mechanism. The experiment was started from the preparation of the ample. At the first step the samples was prepared by cutting in appropriate size by the abrasive cutter. After cutting of the specimens, the experiment was held heat treatment under CHECK for one o’clock. For 0. 4%C different mechanism of cooling (i. E. Air cooling, furnace cooling and water quenching) was used. After proper cooling mounting was the next step.

Hot press mounting machine was used for mounting the sample in order to make suitable for handling and to make the surface flat and zero slope for the next steps. After the mounting the next step was grinding with different sand papers (i. E. 000#) mechanically(by hand) using water as a suspension until flat fine mirror like surface is gotten. And to remove extra scratches the specimen was polished with polishing clothes using diamond suspension in polishing machine for about 50 minute.

Finally before the macrostructure testing the samples was etched by initial (solution of ethanol, HON.. And alcohol) solution for about ten seconds to

make the grain size visible under optical microscope. After the preparation of specimens the first step to examine was macrostructure examination under optical microscope. Standard optical microscope with magnification of XX and XX was used. The experiment result was taken from the optical microscope by using installed camera connecting with computer. To make the result more accurate it was taken five times in each step and for each samples of the experiment.

And using the micrograph’s grain size was determined; using ASTM method formula. N = an-1 1. 1 For determining the volume fraction of permit simply glide line in Microsoft power point was used to simplify the worthy. After optical microscope test Vickers hardness tester was used as the next experiment. This machine is the simplest and as well as the poorest machine and also it is cheap. It tests actually the hardness of the samples, but since the samples are iron (steels) and its hardness properties are related with its strength. The machine was automatic to calculate the hardness of the materials.

But also it can be used using Hall-Peach equation also. 0. 102 X equation 1. 2 hall-peach Using this machine it is easy to see that how the content of carbon in iron can affect the hardness property and also its strength. Finally after reground and retched the sample was tested by scanning microscope by high power magnification to study the macrostructure more accurately. This tool is very rower full and expensive. Here is also the result is read on desktop screen. For simplicity but it is also available to see it using eye peace lens.

It uses electron beam run. 3. Background In this section some important background knowledge about the experiment are composed. Mainly about metals macrostructure, grain size, how grain size determine, hardness property and also about carbon concentration effect on those properties 3. 1. Grain size determination Most of materials properties are dependent in the grain size. Therefore one who need to understand and examine materials mechanical property; should have to now about grain size determination and how it related with materials property.

To determine the grain size the properties of a polycrystalline material are under consideration. Grain size may be measured (estimated) by using an intercept method, described as follows. Equal and straight lines draw through photomicrograph that shows the grain structure. The grains intersected by each line segment are counted; the line length is then divided by an average of the number of grains intersected, taken over all the line segments. The average grain diameter is found by dividing this result by the magnification f the photomicrograph which is gotten from the microscope.

Proper preparation of the specimen is important to get good result of estimation. The rationale behind the assignment of the grain size number to these various Charts is as follows. Let n represent the grain size number, and N the average number of grains per square inch at a magnification of these two parameters are related to each other through the expression N = an-1 2. 2. Phase Diagram and Macrostructure Many physical and mechanical behavior of a material depend on the macrostructure. Macrostructure is a result gotten directly from microscopic observation, using optical or electron microscopes.

In metal alloys, macrostructure is characterized by the number of phases present, their proportions, and the manner in which they are distributed or arranged. The macrostructure of an alloy depends on such variables as the alloying elements present, their concentrations, and the heat treatment and cooling system of the alloy. After appropriate polishing and etching, the different phases may be distinguished by their appearance. For example, for a two-phase alloy, one phase may appear light and the other phase dark.

When only a single phase or lid solution is present, the texture will be uniform, except for grain boundaries that may be revealed. In other hand most of the information about the phase structure of a particular system is displayed in a phase diagram, or some times called an equilibrium diagram. The term phase equilibrium, often used to refer to equilibrium as it applies to systems in which more than one phase may exist. In many metallurgical alloys and materials systems, phase equilibrium involves just solid solution phases.

In this regard the state of the system is reflected in the characteristics of the macrostructure, which necessarily include not only he phases present and their compositions but, in addition, the relative phase amounts and their spatial arrangement or distribution. There are many types of phase diagram, one-component (or unary) phase diagrams, binary ternary, etc. From those phase diagrams binary phase diagram is the most common and important one; in which temperature and composition are variable parameters, and pressure is held constant normally 1 ATM.

Most alloys contain more than two components, how ever an explanation of the principles governing and the interpretation of phase diagrams can be demonstrated using binary alloys. Binary phase diagrams are present the relationships between temperature and the compositions and quantities of phases at equilibrium, which influence mechanical behavior and the macrostructure of an alloy. Many macrostructure develop from phase transformations, the changes that occur when the temperature is altered (ordinarily upon cooling). This may involve the transition from one phase to another or the presence and abscess of a phase.

For a binary system of known composition and temperature that is at equilibrium, at least three kinds of information are available: (1) The phases those are present, (2) The compositions of these phases, and 3) The percentages or fractions of the phases. Determination of Phase Compositions Locating the temperature composition point on the phase diagram is the first step to determine the phase composition. For single and two phase regions different methods are used. If only one phase is present, the procedure is trivial. The composition of this phase is simply the same as the overall composition of the alloy in the operation.

For an alloy having composition and temperature located in a two-phase region, the situation is more complicated. In all two phase regions one may imagine a series of horizontal lines, one at every temperature; ACH of these is known as a tie line, or sometimes as an isotherm. Things are more complex, if the composition and temperature position is located within a two-phase region. The tie line must be utilized in conjunction with a procedure

that is often called the lever rule. The following procedures are usually used for lever rule: 1 .

At the two-phase region the tie line is constructed across the temperature of the alloy. 2. On the tie line the overall alloy composition is located. 3. By taking the length of tie line from the overall alloy composition to the phase boundary for the other phase and dividing by the total tie line length, he fraction of one phase is computed. 4. If phase percentages are desired, each phase fraction is multiplied by 100. Figurer. 2. A portion of the Fee-Fees phase diagram used in computations for relative amounts of protection and pearlier microinstructions for hypothesized and hyperthyroid compositions.. Adapted from Materials science and engineering, W. D. Silicates, 7th destination Wiley and sons Inc. , page 297] For example here on the figure above to determine the relative amount of protection and pearlier micro constituents for hypothesized and hyperthyroid compositions the following steps take place. . 1 (b) Time- temperature-transformation diagram 3. 1 At least one new phase is formed that has different characteristics (chemically physically and a different structure than the t phase that present before.

Most of the time phase transformations do not occur instantaneously, but, begin by the formation of some small particles of the new phase(s), which increase in size until the transformation has completed. There are two steps take place: nucleation and growth. Nucleation involves the appearance of very small particles, or nuclei of the new phase. Growth is increasing the grain size; as a result some or all parent hash may disappear. The transformation completed if the growth of these new phase particles is allowed to proceed until the equilibrium fraction.

Nucleation Homogeneous and heterogeneous are the two types of nucleation. For the homogeneous type, uniform new phase is formed through out the parent phase. Nuclei form preferentially at in homogeneities, such as insoluble impurities, grain boundary, container surfaces dislocation etc.. Homogeneous Nucleation The discussion of nucleation involves free energy (or Gibbs free energy), G. Which is a function of other thermodynamic parameters, of which is the enthalpy H internal energy of the system), and entropy S (measurement of the randomness or disorder of the atoms or molecules).

Relative to phase transformations, an important thermodynamic parameter is the change in free energy a transformation will occur spontaneously only when has a negative value. Pure materials are considered the solidification, by assumption of those nuclei of the solid phase form in the interior of the liquid as atoms cluster together so as to form a packing arrangement similar to that found in the solid phase. And also, it will be assumed that in each of nucleus the geometry is spherical and has a Addis r. The following figure represents this situation.

Figure 3. 3. Schematic diagram showing the nucleation of a spherical solid particle in a liquid. [Adapted from Materials science and engineering, W. D. Silicates, 7th destination Wiley and sons Inc. , page 314] There are two contributions to the total free energy change that accompany a solidification transformation. The first is the volume free energy change, if the temperature is below the equilibrium solidification temperature, Its value will be negative, and the magnitude of its contribution is the product and the volume of the spherical nucleus (i. . , .

The formation of the solid-liquid phase boundary during the solidification transformation is second energy contribution.. Finally, the total free energy change is equal to the sum of these two contributions that is, 3. 2 Figure 3. 4. (a) Schematic curves for volume free energy and surface free energy contributions to the total free energy change attending the formation of a spherical embryo/nucleus during solidification. (b) Schematic plot of free energy versus embryo/nucleus radius, on which is shown the critical free energy change and the critical nucleus radius from Materials science and engineering, W. D.

Cloister, 7th edition, John Wiley and sons Inc. , page 314] Some kinetic principles of solid-state transformations are applied specifically to iron-carbon alloys in terms of the among heat treatment, the development of macrostructure, and mechanical properties. Pearlier The reaction 3. 3 is fundamental in developing steel macrostructure. In there proposes of cooling, austenite, having an intermediate carbon concentration, transforms to a ferrite phase, having a much lower carbon content, and also cementing, with a much higher carbon concentration. In the rate of the austenite-to-pearlier ramification temperature plays an important role.

The following figure shows the temperature dependence for an iron-carbon alloy of eutectic composition figure 3. 4. For an iron-carbon alloy of eutectic composition (0. 76 C), isothermal fraction reacted versus the logarithm of time for the austenite-to-pearlier transformation[adapted from handout of metallurgy, proof. Huh-Chula LEE] It is more convenient to representing both the time and temperature dependence of transformation as per the following figure. Figure 3. 5. Demonstration of how an isothermal transformation

diagram (bottom) is generated room percentage transformation-versus-logarithm of time measurements (top). Adapted from metallurgy handout Huh-Chula LEE] Martinets Martinets is formed when austenite are rapidly cooled (or quenched) with out diffusion. It is single-phase structure and a non equilibrium. In this transformation process FCC austenite experiences a polymorphic transformation to a (BCC) martinets. Mechanical behavior of Iron-carbon alloys Mechanical behavior of some phases (pearlier, and martinets) described below. Pearlier Cementing is much harder but more brittle than ferrite. Therefore increasing the mount of in the steel alloy will make the steel more hard and strong.

Thickness of the layer also affects the mechanical properties of the steel. For instance fine pearlier is harder and stronger than coarse pearlier. Martinets Marionettes are the hardest and strongest, and also it is the most brittle steel alloy. Austenite is slightly denser than martinets, and therefore, during the phase trans- formation upon quenching, there is a net volume increase. Consequently, relatively large pieces that are rapidly quenched may crack as a result of internal stresses; this becomes a problem especially when the carbon intent is greater than about 0. 5 wet%.