Iron carbon diagram explained pdf

Coal plays a dominant role in the formation of iron structure. Iron (Fe) and carbon (C) form a cubic space grid or 3D lattice. The corner points of this lattice contain iron atoms. Carbon atoms can occupy two positions. They are either surface centered in the center of each cube surface, and the result is called gamma mixed crystal (top animation). In the case of alpha mixed crystal, the carbon atom is spatially centered inside the cute. Delta mixed crystal plays a secondary role, but it also has spatially concentrated carbon atoms, however it is used only in high-alloy steels. Carbon is the most important alloying element in iron. The amount of carbon contained in the iron is crucial in terms of the hardness of the material and thus its subsequent usefulness. At this point it is important to note that much more carbon can be absorbed in gamma mixed crystal. Iron and coal form a chemical compound called cementite (Fe_3C). Figure showing a partial diagram of iron and coal The iron-carbon scheme (also called the iron and carbon phase diagram) is a graphical representation of the respective states of the microstructure depending on the temperature (y-axis) and carbon content (x-axis). The actual iron-carbon scheme is much larger than the part shown here. At this point, we take into account only the surface area of steel with a carbon content of up to 2% of the maximum. Iron with a higher concentration of carbon exists – at this point there will be a partial scheme of iron, but this is not of interest to us. Melting is essentially cooled by austenite to ferrite phases - that is, from gamma to alpha mixed crystal. If this process is perceived from the point of view of the crystal structure, carbon atoms try to move from the surface to the center of the crystal. But this position can only be adopted by one atom. The remaining carbon atoms are released and form cementite (Fe_3C). There are various microstructures in the solid state: Ferrite: contains almost no carbon. Ferrite + perlite: As the concentration of carbon increases, cementite is released. This becomes a new component of the microstructure and creates a ferrite microstructure. Perlite: As the carbon concentration increases further, the ferrite fraction decreases. From carbon concentration 0.8... 0.85 %, only perlite is left. Perlit + cementite: If the concentration of carbon continues to rise, cement deposits at the perlite grain boundaries. If examined under a microscope, these bold grain boundaries can be seen. Cementite is a very hard and brittle component of the microstructure. Therefore, in many steel grades it is necessary to prevent the separation of cement. This is done through rapid cooling. If the formation of cement is not prevented, the material can spall under mechanical loads. In metallurgy, the term is used to refer to a physically homogeneous state of matter in which a phase has a specific chemical composition and a separate type of atomic bond and Items. Two or more different phases may be present within the alloy at the same time. The following images show the phases in aluminum- copper and iron and carbon alloys. Al_2Cu deposits in aluminum matrix.© DoITPoMS Micrograph Library, Univ. cambridgeferrite (white) and cementite (dark) steel. Each phase within the alloy has its own physical, mechanical, electrical and electrochemical properties. In carbon steel, for example, ferrite is a relatively soft phase, and cementite is a hard, brittle phase. When they are present together, the strength of the alloy is much greater than that of ferrite, and the plasticity is much better compared to cement. In this way, a alloy with more than one phase can be considered a composite material. See metallurgy & webinars courses Need help with your product? The phases present in the alloy depend on the composition of the alloy and the heat treatment to which the alloy has been exposed. Phase diagrams are graphical representations of the phases present in a given alloy maintained at a certain temperature. Phase diagrams can be used to predict phase changes that occurred in a foot that has been exposed to a specific heat treatment process. This is important because the properties of the metal component depend on the phases present in the metal. Phase diagrams are useful for metallurgicals to select alloys of a specific composition and design and to control heat treatment procedures that will produce specific properties. They are also used to troubleshoot quality issues. Iron and carbon phase diagram An example of a commonly used phase diagram is the iron and carbon phase diagram, which is used to understand the phases present in steel. The amount of carbon present in the iron and carbon alloy, as a percentage by weight, is plotted on the x-axis and the temperature is plotted on the y-axis. Each region or phase field within a phase diagram indicates the phase or phases present for the specified alloy composition and temperature. For the iron and carbon phase scheme, the phase fields of interest are ferrite, cementite, austenite, ferrite + cementite, ferrite + austenite and austenite + cement phase fields. The phase chart indicates that an iron and carbon alloy of 0,5 % carbon maintained at 900 °C will consist of austenite and the same alloy maintained at 650 °C will consist of ferrite and cement. In addition, the graph indicates that as a alloy with 0.78% carbon is slow cooled from 900 °C, converted into ferrite and cementite at a temperature of about 727 °C.Aluminum-Copper Scheme Phase Another commonly used phase scheme is the aluminum-copper phase scheme, which is useful for understanding precipitator reinforcement in Al-Cu alloys. The amount of copper present in the alloy is plotted on the x-axis. The phase fields are al, θ, and Al + θ field phases on the left. If al-Cu precipitation is amplify, this phase chart indicates the minimum temperature to which the alloy must be to place all the copper in the solution. This is indicated by the solvus line in the phase diagram. The maximum amount of copper that can contribute to the strengthening of precipitation is indicated by the maximum amount of copper (5,45 %) which can go into a solid solution in aluminium. Equilibrium phase graphs indicate the relationship between the current phases, alloy composition and temperature under slow heating or cooling conditions. Slow heating or cooling allows atoms in metal to move so that the alloy is in balance. However, with many heat treatment processes, the metal is exposed to rapid heating and cooling. Under these conditions, it is possible to have no phases or presence compared to what the phase scheme indicates. Therefore, it is also important to understand the kinetics of phase transformations, i.e. the effect of temperature, time, cooling speed and heating speed on phase changes within the alloy. This will be the subject of another article. See metallurgy & webinars courses Need help with crash analysis? You can learn more about how to read and use phase diagrams in several of our courses. The metallurgy of steel and metallurgy heat treatment steel teach about the iron phase scheme of coal. Precipitation reinforcement metallurgy teaches you about the aluminum-copper phase diagram. A group of us has held several courses (Metallurgy Principles, Steel Metallurgy, Metal Corrosion) to become more knowledgeable about metal science to avoid problems. For me, the biggest impact of training was on cooperation with suppliers. I feel more confident asking questions and now I know suppliers who know their stuff and which don't. And it was great that I could get training when it was convenient for me. Sam Bloodgood, VP Process Improvement, Hydraforce, Inc. I oversee several operations, including steel heat treatment and laser welding. However, my experience was in the building materials industry. The principles of metallurgy have given me the knowledge to have meaningful discussions with my engineers and be able to ask them better questions. Tom Parkman, Plant Manager, Simonds International. The rules of metallurgy exceeded my expectations. The content was simple enough that it was not cumbersome, but deep enough to provide a practical overview of the basic principles. I recommend this course to any engineer or technical person who has not been in school for several years and works in industry, but does not necessarily focus on metallurgy. Andy Jacobs, Staff Engineer, DePuy Orthopaedics, Inc. The Principles of Metallurgy course is divided into comfortable length modules that can be adapted to the busiest timetable. The course is a good review for engineers who had a class of materials ten or more years ago. Paul Flury B/E AerospaceIt is an excellent course (Steel Heat Treatment Metallurgy) to learn basic heat treatment practices. The course introduces and includes different processes. I recommend it to everyone in the steel industry. Jim Marks, Magellan CorporationThis course gave me more confidence in my work and gave me a better understanding of some of the heat treatments used in the business. Mark Winter, Kute Abbey Products