Novel Process for Observing Phase Transformations in and Strengthening Cast Iron via Controlled Cooling

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A current problem in the metallurgy industry is the high expense and difficulty of melting and shaping steel into intricate shapes. The goal of this project is to develop a novel process for forging high strength cast iron that retains easy machinability in its as-cast form to serve as a more versatile alternative for steel. This is achieved through manipulation of the microstructure of the iron-carbon system in order to achieve a specified mechanical strength in the macro material that can withstand stresses like other high strength materials. The manipulation comes from varying the cooling rate on newly melted iron, but the effects of cooling rate on phase transformations for cast iron are still only vaguely understood. These effects are examined in this project. Generally understood, higher cooling rates should equate to higher values of hardness and mechanical strength. Temperature and resistivity changes were observed as ductile iron samples went through an electrical power heating treatment and a subsequent compressed air cooling treatment. Cooling rate was varied with a computer program in order to examine effects on the microstructure and mechanical properties. Changes of resistivity throughout cooling indicated a change in microstructure, and that observation was supplemented visually with microscopic images of the microstructure and numerically with hardness scale measurements. The samples treated with these novel processes developed different microstructures and different levels of hardness based on different cooling rates. Cooling rate had a significant impact on the mechanical properties of ductile irons that went through the strengthening process.