Making the Most Out of Your Metal Components

The robot you make may be heavy and strong or it may be light and nimble. You may use a hard blade or tough armor. No matter what direction your designs take you, the metal parts that go into your robot will likely benefit from heat treatment. So many metal parts in manufacturing undergo some type of heat treatment to change their mechanical properties for longer life or better performance. Material selection is important in the design phase to ensure your robot performs as you envision. The following lists some common metals to consider in your designs and some of the advantages you can see from their heat treatment:

Aluminum

Aluminum is best known for being lightweight with moderate strength. Aluminum would be great for creating rigid frame members, flipping plates, and other medium duty parts where light weight is most important and plastic or wood materials simply will not do. Heat treatment of aluminum will strengthen the parts to a moderate level where the higher strength and toughness of steels are not needed. Aluminum can often be easily machined once it is hardened, which makes it excellent for last minute modifications and repair.

A typical aluminum strengthening heat treatment might include solutionizing the metal around 1000°F to homogenize the aluminum and alloying elements and then quickly cooling to freeze the structure. Following this, the aluminum is then heated to a lower temperature around 350°F for a longer time to promote the formation of alloy based precipitates that are also frozen to increase strength in the metal.

Carbon Steel

Different steels contain different amounts of carbon and additional alloying elements that allow for a wide variety of heat treatments and performance differences. Although more dense than aluminum, heat treated carbon steel, which is mostly pure iron, can provide overall superior strength and toughness. This means that hardened steel can be smaller or thinner to perform just as well as aluminum. Steel can also be case hardened or nitrided to provide a hard shell and a strong, tough core for high impact parts that need more resistance to wear. Carbon steel should be considered over aluminum for parts anticipated to see excessive impact or very high stresses. It is easiest to machine or form steel prior to hardening.

Typical steel hardening is a process called “Quench and Temper.” In this process, the steel is austenitized at around 1600°F to homogenize the steel and alloying elements followed by a quick cooling known as a quench. The quench creates a hard and brittle metal due to an important phenomenon known as a solid to solid phase change. This is what gives carbon steel its mechanical strength. The steel is then tempered at a lower temperature in the range of 300°F-800°F to reduce the brittle nature and restore some ductility to the metal for superior toughness.

Tool Steel

Tool steels have significantly more alloying elements than carbon steels to encourage a more effective quench and temper or even provide additional gains for wear resistant or highly impacted components. Cutting blades and tools of all types are great applications for tool steel.

Tool steel is most often hardened by a quench and temper process similar to carbon steels. The biggest difference includes the need to run in a vacuum atmosphere furnace due to tighter tolerances and hotter processing temperatures in austenitizing. Tool steels may be tempered in the range of 300°F-1150°F depending on the desired outcome. Machining should be performed prior to hardening.

If you have further questions on what heat treating might be required for your application, please contact one of Paulo’s metallurgical engineers at the provided phone number or email below.

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Free Heat Treating for NRL Teams: Depending on material selected, Paulo will provide free heat treatment for NRL Teams. Please contact our Metallurgy department above to setup your processing. We are proud to support the NRL and want to help all of the teams build the best bots possible. For more information on Paulo or to see our locations, please visit www.Paulo.com