



Does heating an aluminum nail make it harder?

Different types of metal have distinct properties that make them useful for certain types of projects.

Aluminum, for example, is a popular material, especially in construction. It is very easy to bend, form, and cut, which makes it a great material to work with.

Many metals need to be hardened or softened, depending on what type of project they are used for. The way a metal is *processed* affects its strength. The nails in this package are an excellent example. Both came from the same package when purchased. They are made from aluminum alloy 6061, and as purchased have a deformation strength of about 40,000 psi.

For demonstration purposes, a batch of these nails was subjected to a heat treatment designed to *weaken* the metal. The resulting strength is only 8,000 psi - one-fifth of the non-treated nails!

But what if we want to make the nail stronger? We add heat! How can that be? It is all about the processing! “Annealing” is a heat treatment process in which the material is heated to 780°F for 2-3 hours, followed by a *slow, controlled cooling* to *soften* the alloy.

“Quenching”, on the other hand, is a heat treatment similar to annealing, but the aluminum nail is *rapidly cooled* to *strengthen* it. Then the nails go through an aging heat treatment process between 350-500°F, and stay in the oven for 12-24 hours. This process can make the nails five times stronger!

Experiment

To observe some differences between the two nails, drop each one from waist height onto a concrete floor and listen to the sound. The weak nail impacts with a “thunk”, while the hardened one emits a sharp “ping” and bounces upon impact. Then do one of the following:

(1) Try to bend the nails with your bare hands — one is easy and one is difficult.

(2) Try driving each nail into a block of wood. The difference should be obvious.



So why use aluminum? For one, its highly recyclable. This means that it's not nearly as bad for the environment compared to some other materials. It's actually one of the most sustainable metals out there.

It's lightweight and strong. Pound for pound, it's actually stronger than steel. It's around 1/3rd the weight of steel, but it can carry 2/3rds of the same load that structural steel carries.

Steel nails are cheaper and stronger, but should never be used for the installation of aluminum siding. When the aluminum siding is in contact with the iron in the nail, it forms a “battery” in which the iron rapidly corrodes. When the heads disappear from the nails, the aluminum siding falls from the house. To properly install aluminum siding, aluminum nails should be used.

Learn more about ceramics, glass, and materials at ceramics.org/ceramicsarecool.

Demonstration originally developed by Missouri S&T, Materials Science & Engineering, <http://mse.mst.edu>

<https://makeitfrommetal.com/practical-and-common-uses-of-aluminum/>