

## 13.1: Prelude to Metals and Alloys - Mechanical Properties

How much do the mechanical properties of metals and alloys vary with processing? The answer is, a great deal. Consider the following hypothetical situation: Upon graduation, you go to work as an engineer for Boeing. Your job is to work with aluminum companies to help them produce high strength alloys. Why? A large jet airplane weighs a total of 500 tons. Of that total, 50 tons is cargo, 150 tons is the plane structure, and the remainder is fuel. If you can triple the strength of the materials in the structure (aluminum), you can reduce the mass of the structure to 50 tons and increase the cargo to 150 tons. Look at what has been done already:

Material	Tensile strength yield (psi)
pure (99.45%) annealed Al	$4 \times 10^3$
pure (99.45%) cold drawn Al	$24 \times 10^3$
Al alloy - precipitated, hardened	$50 \times 10^3$

By chemical and physical manipulation we have already increased the yield strength 12 times over annealed Al. Yet the yield strength of a "perfect" single crystal of pure Al is ca.  $10^6$  psi. We still have 3 orders of magnitude to go. This just shows that there will still be plenty to do on this project between now and graduation!

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