

# Alloying Elements and Properties of Steel

Here are a few major alloying elements for steel and some information about what they can do.

This list is based on the ["Materials in Action Series; Structural Materials"](#)

Illustration

Element	Influence on Ferrite	Influence on Hardenability	Tendency to form hard Carbides	Major Functions
Manganese <b>Mn</b>	Powerful solution strengthener	Moderate increase	Middle	1. Takes care of <b>Sulphur (S)</b> . 2. <b>Cheap</b> increase of hardenability.
Silicon <b>Si</b>	Hardens, but <b>reduces ductility</b>	Moderate increase	-	1. Deoxidation of <b>liquid steel</b> . 2. Improves oxidation resistance. 3. Strengthens low alloy steel. 4. Increases <b>electrical resistivity</b> ( <b>important for transformer cores</b> ).
Chromium <b>Cr</b>	Strengthens a little Provides corrosion resistance	Moderate increase	Strong	1. Corrosion resistance. 2. Hardenability. 3. <b>Abrasion resistance</b> (needs high C, too). 4. Strength + oxidation resistance at <b>high T</b> .
Titanium <b>Ti</b>	Age hardening possible	Very strong increase	Extremely strong	1. Forms hard carbides. 2. Prevents <b>local depletion</b> of C carbon in stainless steels due to Cr-carbide formation
Vanadium <b>V</b>	Moderate solid solution hardening	Very strong increase	Very strong	1. <b>Restricts grain coarsening</b> of austenite. 2. Increases hardenability. 3. Delays softening during tempering.
Nickel <b>Ni</b>	Strengthens	Mild improvement stabilizes austenite	-	1. Improves strength and toughness at <b>subzero T</b> . 2. Together with Cr provides austenitic steel.
Molybdenum <b>Mo</b>	Age hardening possible	Strong increase	Very strong	1. Increase hardenability. 2. Prevent <b>embrittlement</b> of certain Ni/Cr steels. 3. Keeps strength at higher T. 4. Restricts austenite <b>grain growth</b> . 5. Improves <b>corrosion resistance of stainless steels</b> . 6. Provides carbides with high <b>abrasion resistance</b> .
Cobalt <b>Co</b>	Strengthens in solid solution	<b>Decreases</b> slightly	Like Fe	1. Contributes hardness at <b>moderately high T</b> .

The list could go on for a while, of course. It includes some properties not much discussed before, for example:

- Behavior at low and/or high temperatures.
- Properties like wear (or abrasion) resistance or corrosion resistance (note that stainless steel, while oxidation resistant, might nevertheless corrode in some other chemical environment).
- Making steel in the first place (look for "liquid").
- Counteracting the effects of other elements.
- Keeping the structure from unwanted changes ("grain growth")