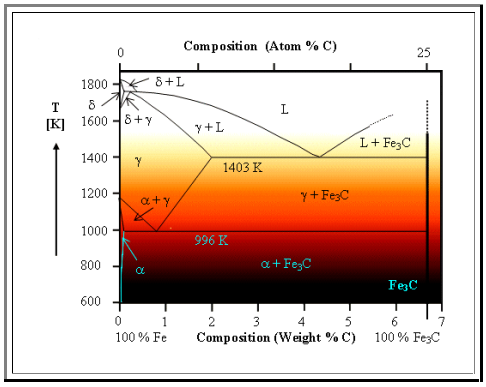
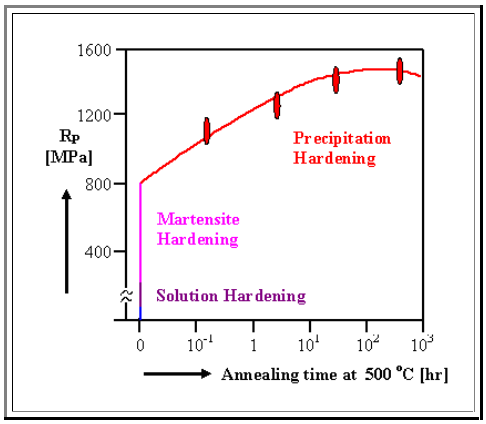
8.4.3 Merkpunkte zu Kapitel 8.4: Steel



- Carbon Steels owe their remarkable properties to the fact that at **996 K** there is a phase change of the eutectoid kind:
  - Above **996 K**: (Non-magnetic) γ - phase, **fcc** lattice; called *austenite*, able to dissolve up to **2%** carbon and still about **0.8 %** at **996 K**.
  - Below **996 K**: (Magnetic) α - phase; **bcc** lattice with hardly any solubility of carbon, called *ferrite*.
- Even if you would start with a relatively defect free γ - phase, the change of lattice type would by necessity introduce many defects and thus lead to some hardening. However, the main hardening effects are due to the need to remove surplus carbon in the α - phase
  - Upon slow cooling one obtains *pearlite*, a mixture of α **- Fe** and *cementite*, which is itself an eutectic of α **- Fe** and **Fe_3C**.
  - Upon fast cooling (= quenching) one obtains "lathes" of *martensite*, a metastable lattice (tetragonal, sort of distorted **bcc**) with the carbon atoms still dissolved. Martensite is very hard, but brittle
  - Tempering below the eutectoid temperature of **996 K** will keep part of the hardness, while restoring some ductility: We have "*tempered steel*", for many years a synonym for the utmost in material strength.



- Adding more alloying element servews to principially distinct goals:
  - "Repair" certain problems, e.g. add **Mn** to compensate for unwanted, but unavoidable **S** in the mix.
  - Produce certain wanted properties, e.g. better corrosion resistance by adding **Cr**.
- However, each addition infringes on *all* properties; optimizing can be long and hard work.
- Nevertheless, an incredible richness of steel variants with a huge spectrum of properties is known and produced.
  - What can be done with respect to the yield strength R_P (proprotional to hardness) is shown in the diagram for the presently ultimate in strength: *maraging steels*. Note that the yield strength of pure ferrite is about **50 MPa**.
- In principle, whatever happens, can be understood by looking at the movement of dislocations.