Names and Steel

Advanced

Here is the list of *names* around steel from the backbone:

- **Cementite** (German: **Zementit**). The stoichiometric **Fe_3C** phase. It is a compound with a complicated lattice and rather hard and brittle.
- **Ferrite** (German: "**Ferrit**). The α-phase with the **bcc** lattice. If you want to be precise, you call it **α - ferrite**.
- **Austenite** (German "**Austenit**). The γ-phase with the **fcc** lattice.
- **Pearlite** (German: **Perlit**), the two phase mixture obtained right below the eutect*oid* point at **0.8 % C** concentration
- **Ledeburite** (German: **Ledeburit**); the two phase mixture obtained right below the eutect*ic* point at **4.5 % C** concentration.
- **Martensite** (German: **Martensit**); a kind of metastable version of *austenite* + carbon; but with a tetragonal lattice and different mechanical properties.
- **Bainite** (German: **Bainit**); a mixture of **α - ferrite** supersaturated with carbon and *cementite*, but in a (non-equilibrium) structure quite different from *pearlite*.

How did those names come into beeing? Let's see:

The name *Cementite* - you might have guessed it - has something to do with the english word "*cement*", meaning something that binds or glues things together in this context.

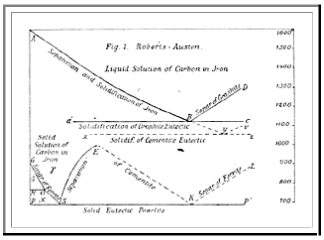
- In the words of a dictionary. "In **1885**, Osmond and Werth published their "Cell-Theory", in which not only the existence of allotropic forms of iron was proposed (now known as austenite and ferrite), but in which also a new look at carbide formation was given. Their research on high-carbon steels, showed that the matrix consisted of grains or cells of iron, encapsulated by a thin layer of iron carbide. During solidification, iron globules, or cells, are formed first and continue to grow. The remaining melt solidifies as ironcarbide. In this way, the carbide-phase actually *glues* or *binds* the previous formed cells together. This view makes it understandable why Osmond called the iron-carbide thus formed, "*Ciment*" (French for binder or cement)".
- Since English and German have words quite similar to the french *ciment*, the precise name did not stick globally but is "*cementite*" in Englisch and "*Zementit*" in German.

Ferrite is practically self-explaining:

- *Ferrum* is the Latin root for many modern words around iron and iron compounds. The word ferrum is possibly of Semitic origin.

Austenite was named after Sir William Chandler **Roberts-Austen**, a British metallurgist (**1843–1902**).

- Roberts-Austen published the first iron-carbon phase diagram; in preliminary form **1897** (below), and in a "final" form in **1899**.



- He is also remembered for being the first scientist who perfomed a quantitative measurement of diffusion in the solid state (**Au** in **Pb**) after A. Fick established his diffusion laws.

Pearlite has its name frorm the pearl-like luster and iridescence of its appearance.

- I could not yet find out, who coined this name and made it stick.
- However, quite recent research can provide an explanation why this particular structure is pearl-like in appearance: The regular spaced lamellae of optically quite different materials form a kind of "photonic crystal" with optical properties quite different from those of the constituents. Real pearls get their luster from the same mechanism; the name "Pearlite" thus is more fitting than its inventor could have known.

Ledeburite is named after Adolf **Ledebur** (**1837-1916**).

- *Ledebur* was the first Professor for "Eisenhüttenkunde" at the (famous) Bergakademie Freiberg. In **1882** he discovered the iron-carbon "Mischkristalle" and became relatively famous. "Ledeburite" as a name for the iron - cementite eutectic was adopted in honor of his achievements.

Martensite was named after Adolf **Martens** (**1850 - 1914**).

- Martens started as an engineer, made it to the director of the royal mechanical laboratory, which evolved into the "Staatliche Materialprüfungsamt" in Berlin. In Germany, a prestigious prize is now awarded in his name.

- *Bainite* is named after the American chemist E. C. **Bain**. In the words of an **US** source:
  - "The history of austempering begins in the **1930**'s, when Grossman and Bain, working for the United States Steel Laboratories, were evaluating the metallurgical response of steels cooled rapidly from **1450°F (788C)** to intermittently high temperatures and held for various times. The outcome of their pioneering research is what we now commonly call the "isothermal transformation diagram" Grossman and Bain were familiar with the conventional metallurgical structures of ferrite, pearlite and martensite. What they discovered, however, was another structure, formed above the martensite start temperature (Ms) and below the pearlite formation region. In steels, this structure took the form of an acicular (plate-like) structure with a feathery appearance. X-ray diffraction later identified this structure as a combination of ferrite and metal carbide. The resultant structure, termed "*Bainite*" was found to be stronger and tougher than a comparable "quenched and tempered" structure.