

4.3.1 Magnetically Soft Materials

Magnetically soft materials are characterized by a slim hysteresis, i.e. a small coercive field strength. It is easy to permanently magnetize them, but small external magnetic fields may also change their magnetization to new values. The characterization “magnetically *soft*” is chosen as to depict this easy (magnetic) access and does not necessarily mean reduced mechanical hardness. **Iron** is the most common soft magnetic material. The crystal structure is also responsible for the magnetic characteristics in addition to the chemical constituents: cold work hardening as well as soft annealing will change the magnetic properties. Even small amounts of additives will change the mechanical as well as the magnetic ‘hardness’.

The **coercive** field strength of magnetically soft materials is typically below 1 kA/m, in special cases below 1 A/m. The **remanent** flux densities most often lie between 0,8 T and 1,5 T. In special cases they can be below 0,1 T. No single value can be given for the **permeability** because it is strongly dependent on amplitude. The relative permeability of cast iron is in the range of 50 to 500. Special metals may reach over 300,000.

Magnetically soft materials are used in pickups to guide the magnetic flux. The flux originating from a permanent magnet is channeled and focused to the strings by magnetically soft **pole pieces**. These pole pieces can be solid metal blocks but also laminated sheet packages or height-adjustable screws. Some pickups (e.g. Fender, old Stratocasters) also may have no pole pieces at all.

4.3.2 Magnetically Hard Materials

Magnetically hard materials should retain their magnetic field after magnetisation as long as possible without external influence; they need a high coercive field strength. They are also called permanent magnetic materials because their field will last for decades if handled correctly. The **coercive** field strength of simple steel magnets is approximately 5kA/m, for the Alnico-alloys often used in pickups it is around 32 – 62kA/m and up to 2000kA/m can be reached with special magnets. The **remanence** is between 0,5T and 1,5T. The permeability is, like in magnetically soft materials, strongly dependent on the working point. Typical μ_r values are from 1 to 5. Magnets with a high coercive field strength tend to have a smaller μ_r .

4.3.3 Non-Magnetic Materials

Only the vacuum is perfectly non-magnetic. μ_r is slightly smaller than 1 for diamagnetic materials, e.g. 0,99998 for Pb, and μ_r is slightly higher for paramagnetic materials, e.g. 1,00002 for Al. Such small effects are completely unimportant for measurements at pickups and also why materials like wood, copper, aluminum, all plastics (PVC, Nylon), varnish, brass, bronze, are considered as non-magnetic (and also non-magnetizable).