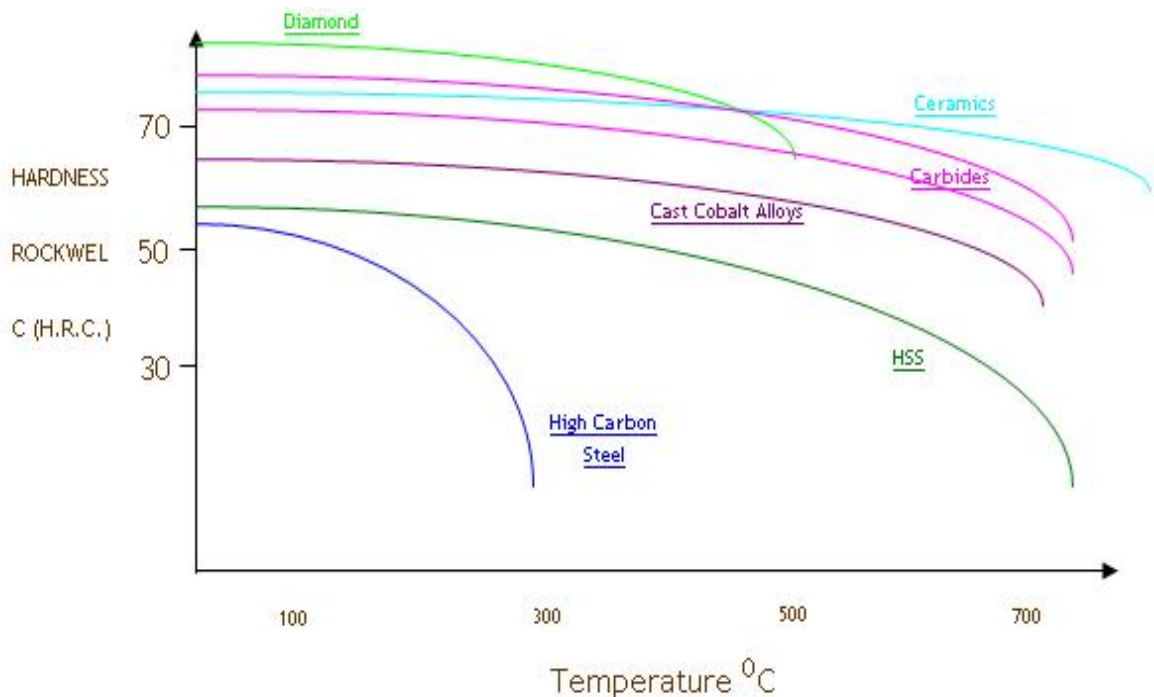


CUTTING TOOLS TYPE

In the past hundred years tool materials have improved dramatically. Until the early 20th Century high carbon steel was the only material available for manufacturing cutting tools.

High Speed Steel was the next development followed by Cast Cobalt Alloys (Stellite), sintered and cemented Carbides, coatings, Ceramic, Diamond and Cubic Boron Nitride (C.B.N.). These materials will be discussed in more detail in the following sections.

(Fig 1)



(Fig 1)

1- HIGH CARBON STEELS

High Carbon (H.C.) steels (1.16 – 1.30% Carbon) are of little practical use in modern manufacturing processes. Up until the early 20th Century they were, however, the only material available. At room temperature, the hardness of H.C. Steel compares favourably with Cast Cobalt Alloy and High Speed Steel, in the region of 55 – 60 H.R.C. (see Fig 1). During the metal cutting process however tool temperature increases dramatically. It can be seen from Fig 1. that the hardness value of H.C. Steel falls rapidly with increasing temperature; consequently only very slow cutting speeds can be employed when using H.C. Steel to prevent rapid dulling of the tool.

2- HIGH SPEED STEELS

High Speed Steels (H.S.S.) were developed in the early 20th century F.W. Taylor and R. White discovered that alloying elements such as Tungsten, Chromium and Vanadium with H.C. steel and subjecting the resulting alloy to a special heat-treatment resulted in a Tool Steel that retained hardness at temperatures up to 600° C – a property known as hot hardness.

Use of this Alloyed Steel for tools allowed much higher cutting speeds than those for H.C. Steels – hence the name High Speed Steel.

3- CAST COBALT ALLOY (STELLITE)

Developed independently to H.S.S., Cast Cobalt Alloys do not use Steel; typically they are composed of 38 to 53% Cobalt, 30 to 33% Chromium and 10 to 20% Tungsten.

Cast Cobalt Alloys or Stellite tools have good hardness (58 to 64 H.R.C.) but are not as tough as H.S.S. . They are suitable for rapid stock removal at elevated temperatures and cutting speeds but are sensitive to impact and shock.

4- CARBIDES

All the tool materials described so far are still limited in their hot hardness, wear resistance and strength.

In 1930s Germany a tool material was developed that combined good hot hardness (Fig 1) and thermal conductivity and low thermal expansion.

Known as Carbides they are produced by a powder metallurgy process, cementing the Carbide particles with a matrix of other metallic powders. The resulting solid is then sintered (pressed together at high temperatures and pressures). At this stage various shapes of tool can be produced prior to final grinding.

Tungsten Carbide (W.C.) uses Cobalt particles as the matrix. The proportion of W.C. to Cobalt affects the property of the finished tool; more Cobalt gives less hardness and wear resistance but greater toughness – more (W.C.) reduces toughness but increases wear resistance.

Titanium Carbide (TiC) has greater hardness but less toughness than W.C.. It is suitable for machining hard materials and higher cutting speeds when a Nickel-Molybdenum Alloy is used as a matrix.

5- CERAMICS

Ceramic tools are made by cold pressing very pure powders of Aluminium Oxide and Titanium Oxide into the required shape and then sintering, in a manner similar to Carbide tools. First developed in the 1950s Ceramic tools are chemically inert, have excellent hot hardness and wear resistance but are very brittle.

6- DIAMOND

Diamond is the hardest known material. It can maintain a sharp cutting edge and has very high wear resistance. Diamond is very brittle therefore Diamond tools usually require a large wedge angle

Diamond tools are usually used for very light cuts to produce exceptionally good surface finishes and geometric tolerances on soft, Non-ferrous Alloys and abrasive materials. Very rigid machines and uninterrupted cuts are required (due to the brittleness).

Diamond is not particularly suitable for Ferrous metals, being Carbon based it possesses a strong chemical affinity to Iron, resulting in degradation of the cutting edge. Very high cutting temperatures also cause degradation of the tip as the Diamond transforms to Carbon.

7- CUBIC BORON NITRIDE (C.B.N.)

C.B.N. is a relatively new invention (introduced in 1962). Second only to Diamond in hardness many of the precautions taken when using Diamond tools need to be applied to C.B.N.. A significant advantage however is that even at high temperatures C.B.N. remains chemically inert to Ferrous metals and resists oxidation, making it particularly suited to machining hardened Steels (hard turning).