CPM S30V, A NEW CRUCIBLE STEEL ESPECIALLY FOR KNIFE BLADES

It is finally here! We have been hearing rumors for about 3 years about a super steel being developed specifically for knife blades by Crucible Materials Corporation. The original idea was to take the basic alloy composition of CPM 3V and add enough chromium to make it stainless. 3V has a reputation for being the steel to use if toughness is the main criteria. The trick was to add enough chrome to improve the corrosion resistance but not compromise the superb toughness to a significant degree. The new composition is called CPM S30V. It is a particle metallurgy based tool steel just like 3V and all the others like CPM S60V and CPM S90V.

A tool steel developed specifically for knife blades is unique. Most of the popular steels in use today by factory and custom makers were developed to meet other needs. ATS 34, 154CM, BG 42 and 52100 are all bearing steels. Medium and high carbon tool steels like O1, L6 A2 and D2 are used for machine cutters, drills, saws and dies The specialty Particle Metallurgy steels like CPM S60V, CPM S90V, CPM 10V and CPM 15V were all initially developed as die steels for the plastics industry.

All of the above can be used to make excellent knife blades but most of them have characteristics that are not needed and can even cause problems for knife makers. For example the high percentage of molybdenum in ATS 34 is there to provide hot hardness in bearings for aerospace applications. Most knife blades are not going to see temperatures above 150 degrees. Therefore the ability to retain hardness at 600 degrees and above is redundant for a knife blade. The high percentage of molybdenum in this steel makes ATS 34 tricky to heat treat especially for the custom maker who has the most basic equipment. The high Vanadium and carbon content in CPM S90V and CPM 10V make for outstanding wear resistance and edge retention but necessitate high heat treating temperatures and specialized equipment. The extremely high wear resistance causes finishing problems for most makers.

OK, so if we could specify the ideal steel for a knife blade what would its characteristics be, and how does CPM S30V compare to this ideal.

First of all let us say that CPM S30V is meant to be a steel that most custom and production makers would want to use for a large portion of their output. It is not intended to replace the super alloys like CPM S60V, CPM S90V and CPM 10V. However it could eventually replace steels like ATS 34/154CM, BG-42, and D2. It could be used for folding knife blades, hunting knives, fillet knives, kitchen knives and tactical knives. The characteristics below are in order of priority and represent my ideas. Others may have a different priority. It should also be understood that it is impossible, for example to have very high hardness, CPM 3V type toughness and corrosion resistance like gold, all in the same alloy. The very best ideal steel is still going to be a balanced compromise between all these attributes. Even with a Particle Based alloy several attributes can be emphasized but at the detriment of some of the others.

Edge holding is of primary importance since it represents what a knife blade does. It should cut for a reasonably long period of time with out being resharpended. The standard in this area is ATS 34/154CM at HRC 60/61 or D2 at HRC 61. Both of these grades will make 40-50 cuts on 1/2 inch rope pretty consistently with correct heat treating. Edge holding depends on correct hardness, high strength, toughness, wear resistance and good corrosion resistance all working together in unison at the fine edge .

The ability to resist significant corrosion is required in professional kitchen cutlery where it is mandated by local heath codes. It is a requirement on fillet knives and also a very nice quality to have on hunting knives because all of us will sooner or later forget to clean off that favorite knife and pay the price the next day. Corrosion can also dull a very fine honed edge while the knife is in the sheath overnight. This is especially true with non stainless steels. The standard here is 440C or again ATS 34/154CM. All three will not show any signs of rust or corrosion if used in and around salt water and given reasonable care. Since our dream steel will be used for kitchen and salt water fishing knives corrosion resistance is a necessary characteristic.

With most popular Stainless blade steels at a hardness approaching 57 we are always trying to trade off hardness and resultant wear resistance with toughness. A Charpy impact value of about 16 to 20 foot pounds is the best we can expect with steels like ATS 34/154CM at HRC 60. We are not so much concerned with bending type toughness because impact resistance is usually the weak link. In other words it is risky to use a super hard, thin ground, slicing type knife built for excellent edge holding for chopping chores. The result can be a chip out of the fine edge or even a broken blade. CPM 3V, the toughness champ has a Charpy value of about 50 foot pounds at HRC 60. A2 at 60/61 for comparison has an impact value of about 40. A Charpy value of around 30 foot pounds at 59/60 HRC would represent a good compromise for the ideal steel since the addition of enough alloy for corrosion resistance is going to tend to decrease the impact toughness.

The ability to be easily heat treated to about 60 HRC or a little higher is very important. Austentizing temperatures of around 2000 degrees will allow custom makers who want to do it all to get good results with fairly basic furnaces and a good hardness tester. Good response will also enable full hardness with batch type processing and air quenching. The end result is consistent and economical heat treating. In my experience A2 is a very nice forgiving steel to heat treat. It would be ideal if the heat treat response was snappy like A2.

The ideal knife steel should be a Particle Metallurgy product. This process allows very fine grain structure and even distribution of carbides. It is also the only way to get a very high alloy content into a steel and still have good properties in the finished product. The even grain structure and absence of large strings of carbides means that the steel can be used at a little higher hardness than a convenitial tool steel and still exhibit good toughness. The particle metallurgy process also insures “clean steel”. The most disheartening thing one can encounter is to work a blade down to 320 grit and find small

inclusions or pits. This means going back to a courser grit and starting all over again. Clean steel is a basic requirement.

Abrasion wear resistance is a primary requirement for a good knife steel. In addition to a 60/61 hardness level the most important ingredient is very hard carbides evenly disperesed throughout the steel matrix. Vanadium carbide is the hardest carbide that is practical to get into a tool steel. It is therefore necessary for the ideal steel to have enough vanadium to combine with carbon to have some residual very small vanadium carbides right at the very fine cutting edge. The very hard carbides act like the rocks in concrete to prevent road surface wear. Enough carbide at the fine edge will add resistance to abrasive wear.

If the best steel possible for knife blades is invented and it's not available then it doesn't do much good. Ideal thickness for knife stock include material that is rolled into sheets and will finish after surface grinding the scale to .125, .150, .200 inches. If sheet stock is available then strips can be cut or blade shapes can be blanked out using laser or water cutting process. Due to the alloy content this material will be more costly than plain carbon steel so the ability to nest blades together on sheet stock is the most economical configuration.

In summary then our ideal " invented for knife blades" steel would have a Particle Metallurgy base for fine grain and cleanness, have enough vanadium carbide to hold an edge better than ATS34/154CM or D2, have equal or better corrosion resistance than 440C, heat treat as easily and be about as tough as A2, and be available in sheet stock in ideal knife blade thick nesses. Is this possible?

Take a look at the chemistry of CPM S30V compared to some of the steels above and we can get a good idea.

BLADE STEEL	CPM S30V	CPM S60V	CPM S90V	154CM	CPM 3V	A2
Carbon	1.50	2.15	2.30	1.05	0.80	1.00
Chromium	14.00	17.00	14.00	14.0	7.50	5.25
Vanadium	4.00	5.50	9.00	0.00	2.75	0.25
Molybdenum	2.00	0.40	1.00	4.00	1.30	1.10
Manganese	*	0.40	*	0.50	*	0.85
Silicon	*	0.40	*	0.30	*	0.35

* not listed on data sheet

A little analysis of the alloy content in CPM S30V can lead to the following preliminary conclusions:

The 1.5% carbon will be high enough for snappy heat treating and formation of a generous amount of Vanadium Carbides for wear resistance at the edge without contributing to finish problems on the blade surface. The carbon will also combine with

Vanadium (the strongest carbide former) and leave enough chromium free for strong corrosion resistance. Molybdenum at 2.0% will yield excellent resistance to pitting type corrosion.

On paper CPM S30V looks like an excellent combination of elements to provide the ideal compromise for a work horse steel for knife blades. There has been a revolutionary growth in custom knife makers and high end factory makers over the last decade. The demand for a new specialty steel just for knife blades has been a long time in the making. The metallurgists from Crucible are knife enthusiasts and have attended some of the major knife shows over the last 3 years. Both Ed Severson and Richard Barber have given technical seminars to bring some knowledge to the knife public. They have seen a need and looks like the new steel is going to fill it . As soon as the steel is available I intend to make a test knife and work out some heat treat formulas that will be best for a knife blade. By that time I should be able to get some feed back from other knife makers who have had a chance to work with CPM S30V. I will use the knife in the field and be in a position to report on the proof of the pudding based on a cross section of users.

Note: This article was written in 2001 and edited for my website in 2006. Both Ed Severson and Dick Barber have left Crucible. Phil