Multi-Layered Steel (Takefu Suminagashi) [redacted]

- 22 layer -

This Suminagashi steel is ideal for making high quality cutting tool and knife blades. It is a lamination of low carbon, non-hardenable steel (11 layers on each side) and an approximately 1.5 mm thick, hardenable middle layer made of Takefu "White Steel" (C = 1.0%, Cr = 0.2 - 0.5%, Ni = 0.7 - 1.3%, Mn < 0.5%, Si < 0.35%, P < 0.03%, S < 0.03%). The steel blanks are supplied in an unhardened state. In order to craft them into blades they are usually forged, ground and hardened. They can also simply be ground and hardened, however additional forging helps the steel's grain become finer and more homogenous.

Heat Treatment

Annealing (normalizing) at 750°-800° C.

Hardening at 780°-820° C. Quenching in oil or lukewarm water (quenching in water will result in harder (+1° to 2° RC), but more brittle steel. We recommend using oil (i.e. vegetable oil) only!

Tempering at 150°-250° (exposure should last until the steel is heated all the way through). Final hardness of 59 - 62 RC. Tempering at a higher temperature or for a longer period of time reduces the hardness of the steel but increases its elasticity.

Forging Recommendation

Takefu steel should, like all steels with a high carbon content, be forged at approx. 800°-900° C (red-yellow heat). Higher temperatures will cause the steel to oxidize and lose its fine-grained structure, lower temperatures can lead to cracks in the steel. To maintain the highest quality crystalline structure, we recommend completing the final steps of forging at a somewhat reduced temperature (750°C) and a higher frequency of hammer blows. Try to keep the time spent heating and forging the steel to a minimum to prevent the carbon from diffusing out of the steel. The best results are attained using a charcoal fire (sulphur and phosphate-free). The steel blank should be fully formed and ground prior to heat treatment.

Grinding

It is very important to avoid temperatures above 150°C once the steel has been hardened and annealed. Grinding it on a dry sharpening machine or belt sander is especially harmful to its crystalline structure. We recommend using a water-cooled sharpening machine or sharpening by hand using Japanese waterstones.

Corrosion Protection

Multi-layered Suminagashi steel is not corrosion-free. We recommend wiping the finished blades with an acid-free oil (camellia oil) to protect them from corrosion damage.

Etching

The visible pattern of the surface of multi-layered steel can be accentuated by etching the blade using an acid solution. The surface of the blade must be 100% free of grease. Use a 20% solution of hydrochloric acid at a temperature of 30°-50°. The treatment takes 10-20 minutes depending on the desired effect as well as other factors. Rinse the blade with water and check it regularly during treatment. The cutting edge layer responds to the treatment quicker than the rest of the blade. The resulting blackening of the cutting edge can be removed by polishing the blade after the acid treatment.

Caution: handling acid is hazardous to your health! We do not provide any guarantees for the quality of the results of this treatment or accept any responsibility for the associated health risks.

Yasuki Steel ("White and Blue Paper Steel")

This carbon steel, supplied by the HITACHI company based in Yasugi, Japan, is made from high-quality iron sand using smelting methods similar to those used to make traditional sword steel. It has the highest purity of all the commercial steels used for forging tools and is commonly forge-welded to a wrought iron base to make high-quality tool blades and knives. Once hardened, the steel has an extremely fine-grained, martensitic structure that displays excellent sharpening properties.

Composition

„White Paper Steel" C 1.1 - 1.2%, Si 0.1 - 0.2%, P<0.025%, S< 0.004%.

„Blue Paper Steel" C 1.1 - 1.2%, Si 0.1 - 0.2%, Mn 0.2 - 0.3%, Cr 0.2 - 0.5%, W 1.0 - 1.5%, P<0.025%, S<0.004%.

Forging

The steel is delivered unhardened. Yasugi Steel should be forged carefully between 800°C to 900°C (red-yellow heat) because of its high carbon content. Higher temperatures will cause the steel to oxidize and lose its fine-grained structure, lower temperatures can lead to cracks in the steel. To maintain the highest quality crystalline structure, we recommend completing the final steps of forging at a somewhat reduced temperature (750°C) and a higher frequency of hammer blows. Try to keep the time spent heating and forging the steel to a minimum to prevent the carbon from diffusing out of the steel. The best results are attained using a charcoal fire (sulphur and phosphate-free).
The steel can be forged-welded to wrought iron (at temperatures of 1100°C, yellow-white heat) with the addition of Borax. Make sure both the forge and anvil are clean prior to forge-welding.

The heat treatment of the blank after forging involves three steps:

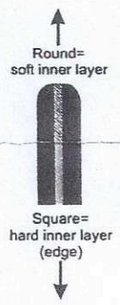
1. Annealing: Prolonged baking at temperatures slightly less than hardening to produce a uniform, crystalline structure.
2. Hardening: Heating to the hardening temperature and subsequently quenching the steel in lukewarm water or oil.
3. Tempering: Heating to a lower, tempering temperature to reduce the mechanical stress built up during the forging process in the structure of the steel.

The steel blank should be fully formed and ground prior to heat treatment. It is very important to ensure an equal distribution of heat in the forge or to use a special hardening chamber. We have provided some values below for reference. The actual values may vary somewhat depending on several other factors (surface structure, time, laminate structure).
All temperatures are listed in °C.

„White Paper Steel" Annealing temperature: 740°C - 770°C
Hardening temperature: 760°C - 830°C (Fig. 1)
Quench in lukewarm water or oil *
Tempering temperature: 180°C - 220°C (Fig. 2)
Final hardness ca. 62 RC

„Blue Paper Steel" Annealing temperature: 750°C - 780°C
Hardening temperature: 780°C - 830°C (Fig. 3)
Quench in lukewarm oil
Tempering temperature: 160°C - 230°C (Fig.4)
Final hardness ca 62 RC

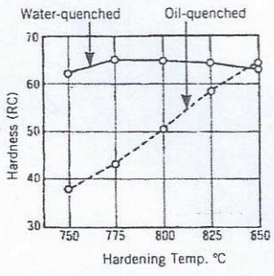
Please note:
For laminated "Katana" blade material (No. 719617, 719618) the Paper Steel is on the side with sharp rectangular edges.



It is important that the steel be heated slowly and uniformly during the annealing, hardening and tempering process. The higher the annealing temperature and duration is, the less hard and more elastic the resulting steel. (Fig. 2 and fig. 4).

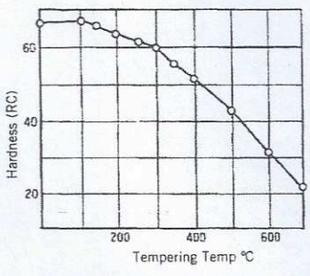
* Tip: We recommend using oil (i.e. vegetable oil) as it reduces the risk of cracks, especially in thin pieces.

Fig. 1



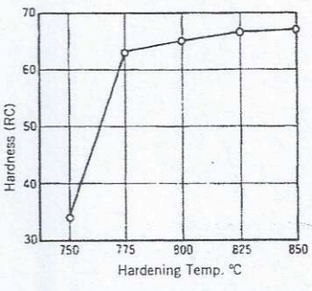
Hardness as a factor of hardening temp. for „White Paper Steel" when quenched in water and in oil (dotted line).

Fig. 2



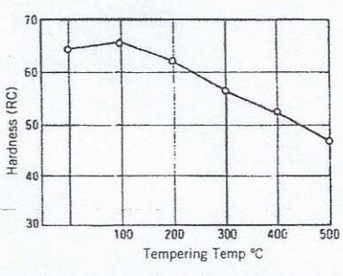
Final hardness as a factor of the tempering temperature for „White Paper Steel" (hard-ened at 775°, quenched in water).

Fig. 3



Hardness as a factor of hardening temperature for „Blue Paper Steel" when quenched in oil.

Fig. 4



Hardness as a factor of tempering temperature for „Blue Paper Steel" (hardened at 800°C, quenched in oil).

Grinding

It is very important to avoid temperatures above 150°C once it has been hardened and annealed. Grinding the steel on a dry sharpening machine or belt sander is especially harmful its crystalline structure. We recommend using a water-cooled sharpening machine or sharpening by hand using Japanese waterstones.

Corrosion Protection

Both „White" and „Blue Paper Steel" are not corrosion-free. We recommend wiping the finished blades with an acid-free oil (camellia oil or Ballistol) to protect them from corrosion damage.