Käthe Harnecker and Wootz Blades

Advanced

Käthe Harnecker was born in (probably) 1891. Hardly anything is known about her but she must have been an amazing woman. From 1916 - 1922 she was the head of the metallographic laboratory of Borsig in Berlin. Once upon a time (1872 to be exact) Borsig was the largest producer of locomotives in the world. Around 1920 it was still a rather large company. Employing a woman as head of its metallographic laboratory can only mean that Käthe Harnecker must not only have held some suitable degree but that she must have been an outstanding person.
In 1922 Käthe switched to J.A. Henckels in Solingen, still one of the largest and oldest manufacturers of kitchen knives, scissors, and so on; known since 1731 by its "Zwilling" (= twin) name and emblem.
The British occupying forces shut down the company between 1945 and 1948 but after that Käthe Harnecker was still working for Henckels until 1956, having reached the retirement age of 65, it seems.

Käthe started experiments with high carbon steel. Why she did that is is not so clear but she knew the Russian attempts of reproducing the fabled "damascene" steel and she knew that earlier attempts of Henckels had failed. It might have been scientific curiosity plus the hope to come up with superior steel for some products of the company. She published her results in two **papers**:

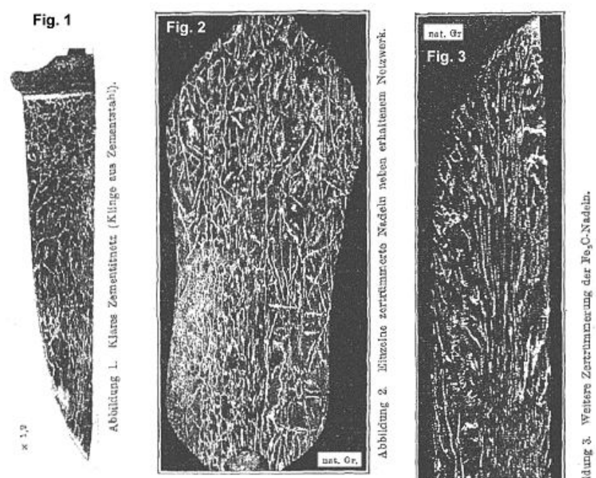
1. K. Harnecker: "Beitrag zur Frage des Damaszenerstahls", Stahl und Eisen, 44. Jahrgang **45** (1924) pp. 1409 - 1411; pictures on (separate) tables 7 and 8
2. K. Harnecker: "Z.H.W.K. (Zeitschrift für Historische Waffenkunde) Vol. 2 (1926 - 1928)

The links lead to the first paper and the pictures therein.

What Käthe did was to first produce some high carbon steel - by cementation (!) and by using modern crucible steel. From what she wrote it becomes clear that she had good ideas, based on science, of what needed to be done to produce a pattern:

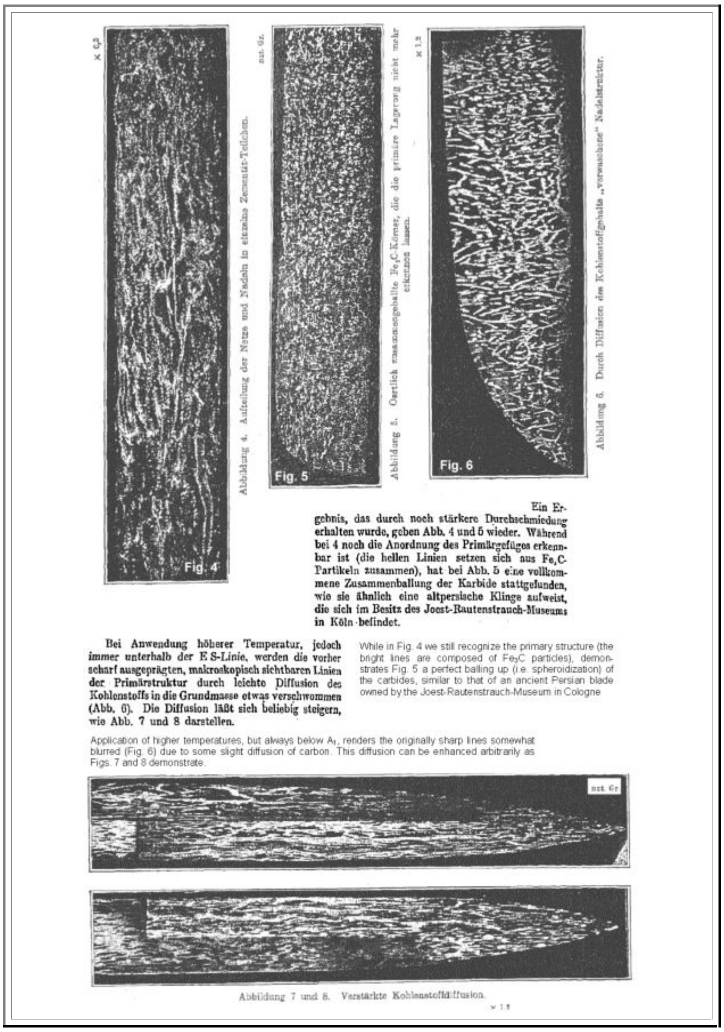
- Cool slowly; produce a coarse crystalline structure.
- *Long needles* of cementite result (Widmanstätten structure?) that must be broken up by forging. This leads to:
- Needle break-up. The intricacy of the pattern depends on the severity of forging. Perfect spheroidization is achievable.
- Most important: keep forging temperatures as low as possible!
- Some annealing (below A_1 temperatures) makes the patterns "fuzzier" and the resemblance to old wootz patterns closer.

Some knifes with very satisfactory properties were forged this way.
Here are the highlights from publication 1 with the relevant original text plus (my) translation. Look at the large scale rendering for reading:



Das Jagdmesser in Abb. 1 mit einem Kohlenstoffgehalt von etwa 1,2 % zeigt noch ein klares Netzwerk von Zementit (Netzdamast?), desgleichen der etwas stärker durchschmiedete Werkstoff in Abb. 2, in welchem jedoch neben den in der äußeren Form erhaltenen einzelne zertrümmerte Nadeln auftreten. Einen weiteren Fortschritt stellt Abb. 3 dar, die vorwiegend zerstörte Karbidformen zeigt.

The hunting knife in Fig.1 with a carbon content around 1,2 % still shows a clear network of cementite ("Net damast"?), just as the somewhat more strongly forged material of Fig. 2, in which, however, besides retained needles also single broken needles are found. A further progress (towards making "nice" wootz") is shown in Figure 3, showing predominantly destroyed carbide shapes.



Käthe must have made some more knifes after the war. Manfred Sachse saw these knifes and has a picture in his wonderful book (from which I also took the data about Käthe Harnecker). Here it is:

Is this "real" wootz or not? Who cares. Beyond doubt is the fact that at least Käthe Harnecker knew quite a bit about the science of producing wootz patterns already in 1924. Later giants of wootz, like Wadsworth or Verhoeven, were obviously not aware of her work, and that is quite understandable.
However, I think it is time to set the record straight. It is simply not true that at "an **international conference at New York University in 1985** ... it was concluded that there was no known bladesmith who could successfully reproduce a wootz Damascus blade. Concurring in this decision were Smith and G.N. Pant from the National Museum in New Delhi. Smith had come to the conclusion that the surface patterns resulted from formation of primary carbides (Fe_3C) in the dendritic structure of the wootz ingots from which the blades were forged".
Verhoeven wrote that in 1987.

- At the latest in 2002 Verhoeven was aware of Harnecker's work. In the "Genuine Damascus Steel: A type of banded microstructure in hypereutectoid steels" paper he writes:
  The basic method of W-S (Wadsworth / Sherby) was actually utilized prior to their work by Harnecker at the Henckels Company in Solingen. She prepared high carbon steel by carburizing both a fairly pure Swedish iron and an ingot steel at 1000 - 1100 °C for 10 - 12 days followed by slow cooling, which would have produced the cementite array for step 1 of the W-S method. She was careful to do subsequent forging below the A_{cm} temperature. The microstructures obtained display coarse blocky cementite particles with an elongated grain structure similar to those found in our work.