

## 11.5.3 Forging a Wootz Sword

### Early Wootz Swords

Let's engage in our stupid little game once more:

**Who made the first wootz sword with a nice patterned blade?  
When and where?**

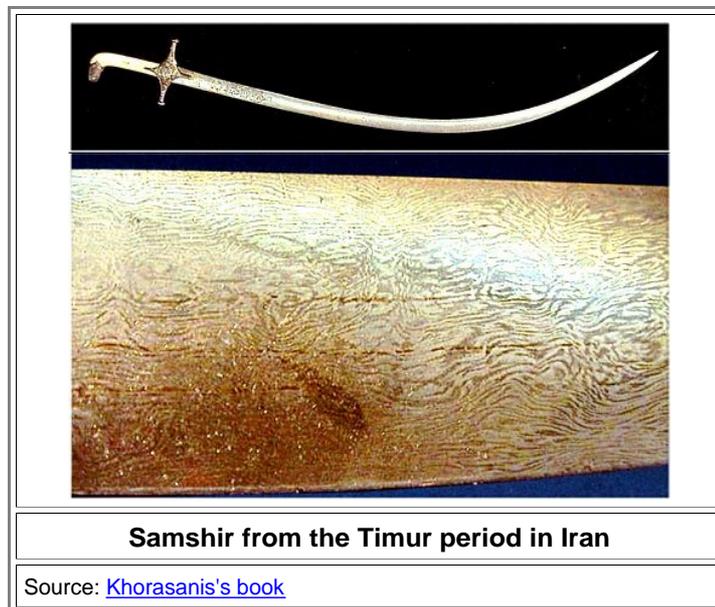
Like always, it is a tricky question with no definite answer. First I will make clear what I did *not* ask:

- I did *not* ask who made the first blade from *crucible steel*. That happened probably much earlier. But blades made from crucible steel do not necessarily show a pattern. The "[Ulfberht's](#)" possibly made from crucible steel around 1000 AD did most certainly *not* show a pattern. That can be deduced from their [microstructure](#).
- I did *not* ask who made the first blade from crucible steel that showed *some* pattern *by accident*. Any UHCS, as we have seen, will easily produce some pattern - but not necessarily a nice one.
- I did *not* ask who made the first blade from crucible steel that *could* have shown a nice pattern if properly etched. It is conceivable that smiths made blades with the proper banded cementite structure for a *nice* pattern without having been aware of that. Since rather special forging techniques are needed, it doesn't appear to be very likely, though.

The question is thus only about the smith who *conscientiously* forged a blade and finished it with the intent of making a *nice* pattern.

There is of course no definite answer to this question. We can be rather sure that "pattern forging" evolved over many years, from a process where blades with some pattern were created more or less accidentally, to a process where materials and forging techniques were optimized. That took many steps and the process of making blades with a nice pattern probably required a century or two for maturing.

The first blades with (very) nice patterns shown in [Khorasani's magnificent book](#) are from the Timurid period 1370 AD - 1500 AD. Here is one:



The patterns on the shamshirs shown are so perfect that they must have been based on an older tradition. While quite likely older blades with a nice pattern exist somewhere out there, I have yet to see one. So for answering our question we must turn to early writings.

I have already done this in the [special module](#) "Antique Texts Concerning Crucible Steel". There you can read that **Al-Kindi** (ca. 800 AD - 873 AD) mentions that swords made from pulad (=wootz) exhibit a pattern (known then as "firind" or "jawhar") and that might be the first description of the "water" pattern obtainable with some crucible steel. Then we have **Al-Biruni** (973 AD - 1048 AD) who also comments on the "water" pattern that could be produced with crucible steel. And so on.

We also have [Anna Feuerbach's analysis](#) of a few old blades from the 3rd–4th century AD that were made from crucible steel that sported aligned spheroidal cementite, the metallographic feature needed for a nice visible pattern. It is not clear, however, if the smith was intentionally going for a pattern and what it would have looked like.

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All things considered we might be justified in assuming that blades with a *nice* pattern have been around a least since 800 AD. Perhaps even somewhat longer but probably not much longer because in many much older documents from India, crucible steel and patterned swords are never mentioned.

That opens the interesting questions if one of the most famous swords in history, the Zulfiqar of the Prophet Mohammed, was a wootz blade?

[Advanced Link](#)

Zulfiqar

### Making a Mohammed's Ladder

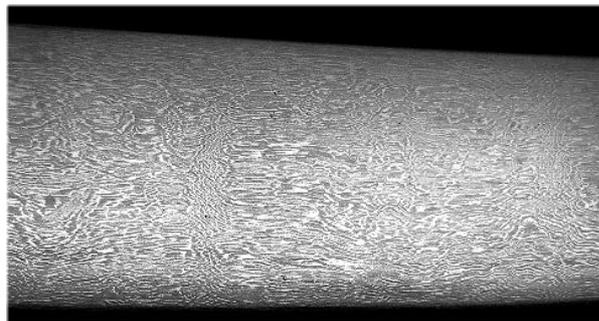
From the preceding modules it should be rather clear how a "normal" wootz blade was forged. The key points were:

- Start with a suitable ["wootz cake" or "bulad egg"](#). It needs to be a high carbon steel, homogenous without slag inclusions, and preferably with traces of strong carbide formers like vanadium (V); some manganese (Mn) wouldn't hurt either.
- [Spheroidize the cementite](#) if that has not already happened during the cooling of the crucible steel. It is not clear (to me) if the ancient smiths used some special procedure for doing that right at the beginning of the blade forging or if spheroidization happened as a by-product of the forging process.
- After spheroidization you must keep the temperature rather low. If the blade ever gets above the [A1](#) temperature for some time, all is lost.
- The necessary [Ostwald ripening](#) demands several temperature cycles between just above the ferrite - austenite transformation temperature around 730 °C (390 °F) for just the right time. That may just happen by the forging process itself if done just right.

Depending on all the details, you end up with a wootz blade that shows one or the other of the less intricate [patterns](#).

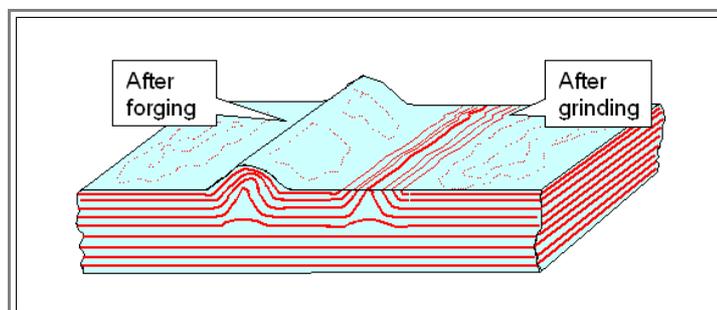
- But now we want to make a [step pattern](#), better known as **kirk nardeban** or **Mohammed's ladder** with **"roses"** in it.

The picture below (from an Indian wootz blade in my possession) shows a few weak "steps". The smith has made an attempt at a kirk nardeban pattern and succeeded for some ladder rungs in parts of the blade but not everywhere.

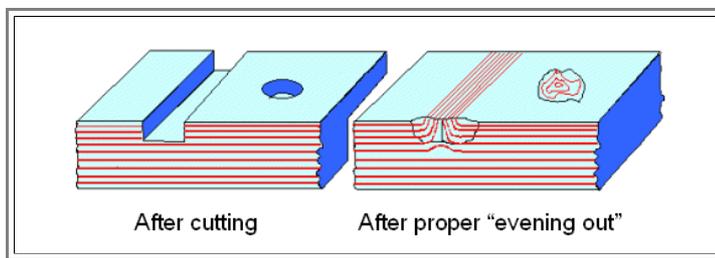


Three faint rungs of a kirk nardeban pattern

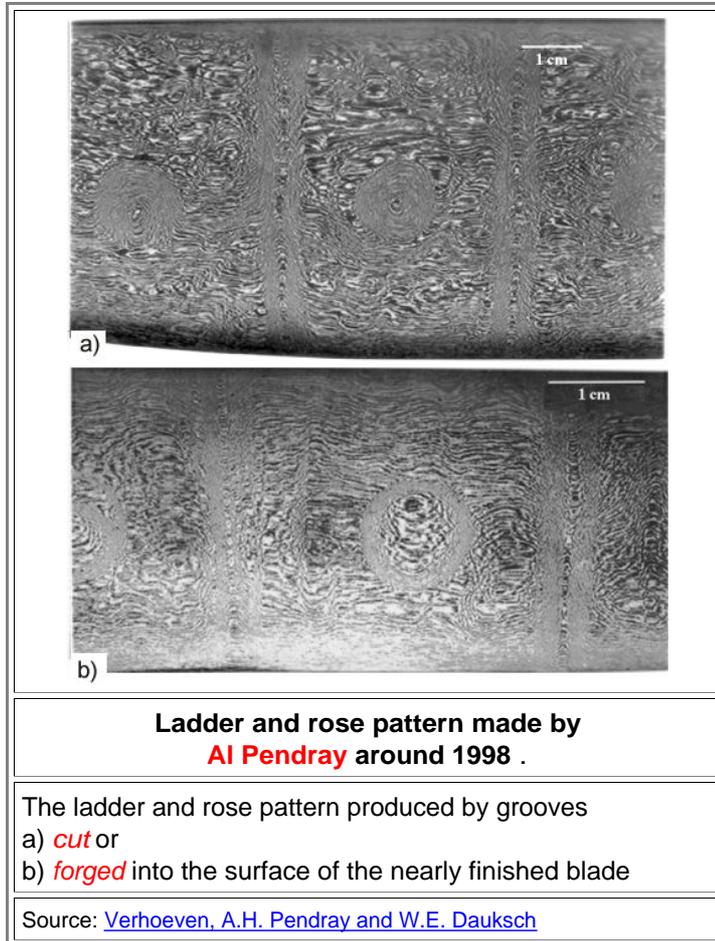
- How is it done? The principle is easy. Make a hump in the otherwise somewhat wobbly but planar stack of your cementite precipitate planes. Schematically (very schematically, I'm not an artist) you could produce something like this:



- What also works is to cut grooves as shown below, followed by the more tricky part of "filling" them again, This "evening out" the blade must be done in such a way that the cementite planes are arranged as shown.



You might also make grooves by cutting with a chisel and God smiths know in how many other ways. That this works has been demonstrated by Al Pendray, his results are shown [here](#) and below I show them again:



I really don't know how you do all this in detail - [ask a smith!](#) The only problem is that there aren't too many around right now who could tell you. And the few who could will probably keep their mouths shut. Anyway, the principle of manipulating wootz patterns is clear. The principle for making a major marble sculpture like [this one](#) is also quite clear: Take a big piece of marble and knock off whatever is not needed.

- The guy who makes a [great marble sculpture](#) we call an artist, and his work a piece of art. I do not hesitate to call a smith who makes a wootz sword like the ones shown here an artist too, and his work a piece of art. And now we are right back to the [beginning of this hyperscript](#), far, far away.

### The Myth Around Wootz Swords

Wootz swords with a nice "water" pattern were supposed to be unbelievably good, far better than anything else. A whole mythology developed around this. Since the "Japanese sword" enjoyed the same mystification process, I won't go into much details here but do that in the next module.

Wootz swords, for example, were believed to be unbelievably sharp. You even could cut stones with a wootz blade without the slightest damage to the blade. And of course you could bend them around your waist without any problems.

- We have encountered some of these claims before:
  - In [this link](#) Sultan Saladin cuts a soft silk cushion with his wootz scimitar.
  - [Here](#) the (wootz) blade is "bent around the body of a man and breaks not". The author of this contribution actually makes fun of the wootz mythology but must have based his satire on the claims he encountered around 1890.
  - In this [module](#) a stone is cut in half by a wootz blade wielded by one of Germany's biggest if fictive hero.

Of course, the mythology around wootz swords owns quite a bit to all the [early](#) and [later](#) writings concerning the "secret" of the Indian steel, and to the fact that crucible / wootz steel was indeed better in some respects than other *old* steels throughout the millennia. No doubt about that. However, even the best wootz is just a (ultra) high carbon steel, and even with spheroidized cementite this steel has its limitations.

How good wootz (or "true" damascene) blades really are is something one can find out. Prof. **Zschokke** (an early metallurgist from Switzerland) was lucky enough to get a few wootz blades for (destructive) investigations. This is quite unusual because these blades are valuable and museums and collectors do not easily agree to have some of them destroyed.

Manfred Sachse in his [book](#) reports some of Zschokke's results. Here are a few:

General composition					
Sample	[C]	[Si]	[Mn]	[S]	[P]
1. Wootz Saber	1,874	0,049	0,005	0,013	0,127
2. Wootz Saber	0,569	0,119	0,159	0,032	0,252
3. Wootz Saber	1,324	0,062	0,019	0,008	0,108
4. Wootz Saber	1,726	0,062	0,028	0,020	0,172
5. Modern welded steel saber	0,606	0,059	0,069	0,007	0,024
6. Modern cast steel saber	0,499	0,518	0,413	0,038	0,045

Properties						
Sample	1	2	3	4	5	6
Bending toughness	13,4	15,2	11,5	14,5	21,6	30,0
Work to bend	94	221	55	63	361	622
Angle of bending	27	59	19	17	69	78
Hardness	216	233	193	248	347	463

Specimen 1 - 4 were wootz blades, 5 and 6 were modern early 20th century welded and cast steel blades from Solingen. They were the winners in every category.

Nothing very special or very good about wootz blades. Well, we already know that from what I have written before. You can also read a [short article](#) from **Stephan C. Alter** from 2017, entitled: "On Slaves and Silk Hankies. Seeking Truth in Damascus Steel" that puts all these myths in perspective.