

Internet (and Other) Literature to Damascene (and Other) Techniques in the Production of Iron and Steel

Advanced

Following are the notes I took while reading through some Internet papers and which I will share with you.

Note: There is no guarantee that the direct Internet addresses always given are actually working. They worked, however, in May **2000**. The links in the headlines for each contribution therefore lead to the original version of the contribution *stored in a file* within this hyperscript.

- I do not want to infringe on copy rights. Since all articles are (or at least were) available in the the net, I assume that the authors actually want their papers widely distributed and read. Since this hyperscript is available in the Internet without charge, I trust that I did not violate any copyrights.
- Check also the following modules of the Hyperscript:
 - [Damascene Technique in Metal Working](#)
 - [A cross-linked glossary of terms around the history of metal working](#)
 - [History of Steel](#)

But before we go into the Internet "literature", I must mention the wonderful book by **Manfred Sachse**: "*Damaszener Stahl - Geschichte, Mythos, Technik, Anwendung*" (Verlag Stahleisen, Düsseldorf; I'm told, it also exists in English)

- This book is not only only remarkable because it was written by an actual [practicing smith](#), but because of the wealth of (first-hand) information it contains. Nothing directly available in the Internet comes close.

[Steel in Ancient Greece and Rome](#)

E. A. Ginzel

- Direct Internet Address: <http://www.mri.on.ca/steel.html>
- Note: the number in brackets in the paper do not refer to the list of references at the end of the article, as is common in scientific papers, but to some footnotes not included in the Internet version.
- Purports to show that the ancient Greeks and Romans knew more about steel that credited for so far. Includes a short but informative discussion about what steel is.
- Sees wootz steel as the source of the raw steel from about **500 BC** and describes two ways of how it was produced in India. Wootz steel made with the second method had an Fe content of about **1,5% - 2%**, this came close to the region of (gray) cast iron. The **C**, however, was precipitated as cementite (**Fe₃C**) and not as graphite as in cast iron.
- One of the main points in this article is that ancient smiths in the Mediterranean (in other words: Not the Indians themselves) found out how to forge this wootz steel into a material with "amazing strength and toughness" by hammering at a specific temperature.
- This forging technique also is supposed to explain the "swirl coloration" (otherwise known as "water pattern") of the Damascus steel and traces its origin back to **330 BC**. Damascene technique here thus does not rely on the weld forging of two different kinds of steel.
- The romans, however, did not exploit the Damascus steel technique or tried (or succeeded ?) in emulating the wootz steel production.

[Metallurgical Heritage of India](#)

S. Srinivasan and S. Ranganathan

Dept. of Metallurgy, Indian Inst.. of Science, Bangalore

Direct Internet Address: <http://www.metalrg.iisc.ernet.in/dept/heritage.html>

- A brief review of the major aspects of mining, smelting and working all major metals in antiquity with particular emphasize on India (which actually has a really outstanding record of early metal technology).
- A brief account of the importance of **wootz steel** for western technology
- Some interesting quotes from antiquity and a glimpse of how the efforts to unravel the mysteries of wootz steel and damascene blades prodded along western technology in the **19th** century.

[WOOTZ STEEL: AN ADVANCED MATERIAL OF THE ANCIENT WORLD](#)

S. Srinivasan and S. Ranganathan

Dept. of Metallurgy, Indian Inst. of Science, Bangalore

Direct Internet Address: <http://metalrg.iisc.ernet.in/~wootz/heritage/WOOTZ.htm>

- An expansion of the article cited above, unfortunately without pictures.
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[The Key Role of Impurities in Ancient Damascus Steel Blades](#)

J. D. Verhoeven, A.H. Pendray, and W.E. Dauksch

Iowa State University, Materials Science and Engineering Department

This article appeared in the journal: JOM, 50 (9) (1998), pp. 58-64.

Direct Internet Address: <http://www.tms.org/pubs/journals/JOM/9809/Verhoeven-9809.html>

- The authoritative article about how to make "true" Damascus blade with wootz steel.
 - Quite informative, but does not comment on the properties of the emulated blades, however. (Could they be bent into a semicircle and so on?)
 - Stresses the role of trace impurities for the generation of "true" Damascus blades.
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[The Road to Damascus - Sorting Modern Pattern Welding from Myth and Legend](#)

Kevin R. Cashen

Master Blacksmith, USA

Published in the magazine "Sword Forum"; Direct Internet Address: <http://www.swordforum.com/forge/roadtodamascus.html>

- The authoritative article about how to make "folded" Damascus or pattern welding today by a real blacksmith. One of the articles I enjoyed most.
 - Gives a good overview and does away with some myths surrounding damascene technique.
 - Comments especially on "quality vs. appearance". Damascene blades (in the meaning of folding or pattern welding) are **not** superior to good homogeneous steel!
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[WATERED STEEL, WOOTZ AND TRUE DAMASCUS](#)

Lord Mikal Isernfocar called Ironhawk (???)

Published in: The Vigil; Barony Of Middle Marches; Volume XVIII Issue V AS XXXII September 1997

Direct Internet Address: http://www.ald.net/middlemarches/vigil/1997/V_9709.htm

- Thank God, there will always be an England! (to quote the "new Yorker"). The article above, though published in surroundings probably not recognized as serious, peer-reviewed scientific journal, puts forward, without a trace of uncertainty, a completely different technique for producing "true" damascene blades!
 - "Low carbon wrought iron was hammered into very thin sheets. A stack of these sheets was wired together in a tight bundle. A batch of high carbon cast iron was heated until molten. The bundles of low carbon wrought iron were plunged into the vat of high carbon cast iron. The cold wrought iron would 'suck' the molten cast iron into the spaces of the bundle by a process called capillary action. This would partially remelt the wrought iron, 'welding' the bundle together into one solid mass. This mass was forgeable for a short time, so it was hammered into rough shape while it was still hot".
 - Otherwise, the article contains much of what has been stated elsewhere.
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[The Serpent in the Sword: Pattern-welding in Early Medieval Swords](#)

Lee A. Jones

the persons who keeps a really interesting site in the Internet (try "home" at the end of the article)

Direct Internet Address: <http://www.vikingsword.com/serpent.html>

- Everything you want to know about pattern welding in the European history.
 - Explains in detail how the pattern emerge upon twisting and grinding.
 - Many pictures of real swords as well as very informative drawings.
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Ancient carburization of iron to steel: a comment

[Donald B. Wagner](#)

[Department of Asian Studies](#)

University of Copenhagen

Direct Internet Address: <http://donwagner.dk>

- Can you produce steel from wrought iron by heating it in charcoal? D. Wagner, citing a book from 1790 and doing some calculations thinks you can - refuting a 1989 claim from another scientist that you cannot! A nice illustration to the rapidly growing field of archeometallurgy!

Early progress in the melting of iron

V.H. Patterson and M.J. Lulich

This paper was presented at the 44th International Foundry Congress, held in Florence in 1977

Direct Internet Address: <http://members.tripod.lycos.nl/cvdv/historycastiron.htm>

- Short history in the development of cast iron from the Chinese to the tricks of the British in the 15th century. Did the British defeat the Spanish armada because of their superior iron technology?

Damascus Steel - A Brief History

Motoyasu. (Edited by WarAngel)

Direct Internet Address: <http://www.angelic.org/highlander/metallurgy/damascushistory.html>

- Very short and very concise! Contains most of everything, even the specific Japanese development.

Blade Patterns Intrinsic to Steel Edged Weapons

Several authors; the link brings you to a starting page, or use the

Direct Internet Address: <http://www.vikingsword.com/ethsword/patterns.html>

- Contains examples from all over the world (Bali, Japan, Philippine, India, ..). Otherwise like the "[Serpent in the Sword](#)"

History of Swords from Toledo

? Some agency to promote tourism

Direct Internet Address: <http://www.intercom.es/espadas/history.htm>

- Some Hyperbole about the great swords from Toledo

From Rapier to Langsax - Sword Structure in the British Isles in the Bronze and Iron Age

by Niko Silvester

Direct Internet Address: <http://www.vikingsword.com/smithy/seax.html>

- A short but rather clear history of the development of sword types (with some remarks to their making) in the British Isles.