

Nanostructured Ancient Damascus Blades

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Legends tell how Damascene blades exhibiting extraordinary mechanical and optical properties had been manufactured following secret recipes (Validi (1936), Panseri (1965), Piaskowski (1978)). During the last decades more sophisticated metallurgical methods have revealed details of the microstructure of this crucible (or wootz) steel. There are indications that impurities and unconventional thermo-mechanical treatments might have an essential influence on the typical Damast pattern (Sherby (1995),Verhoeven (1998)). Using scanning and high-resolution transmission electron microscopy, X-ray diffraction as well as micro- and nanohardness measurements we have analysed specimens of two genuine Damascus sabres, which date back to the 17th century. They were kindly left to us by the Historic Museum Berne. Significant new details of the microstructure that have been revealed during our study are nanowires of cementite Fe₃C (Kochmann (2004), Levin (2005)) as well as carbon nanotubes (Reibold (2006)) and present work). Moreover, using X-ray diffraction, Fe₇C₃ has been detected which is known as catalyst for hydrocarbon synthesis and which eventually converts to Fe₃C (Herbstein (1964)). Since carbon nanotubes have become known as forming catalytically from natural fibres (Goodell (2007)), this sheds a new light on early reports on the addition of organic material (wood, leaves) into the crucible, which was used by Indian metallurgists (Schwarz (1901)). Hence, we speculate that there is a connection between transition metal impurities, hydrocarbons, nanotubes, nanowires and cementite pattern. Moreover, the existence of ordered cementite wires at nanoscale should have consequences for the mechanical properties. In addition to the nanoindentation measurements mentioned above, we have performed nanoscratch tests to characterise the striking stability of the cutting edge more quantitatively.

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Abs. No. **208**
Meeting: **DMG 2008**
submitted by: **Paufler, Peter**
email: **paufler@physik.tu-**
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date: **0000-00-00**
Req. presentation: **Poster**
Req. session: **S17**