Diffraction measurements of the Axe of Ahneby

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First evidence of metal using in northern Europe can be dated back to the fourth millennium BC. In the following millennium the craftsmen started experimenting with different alloys and tools. In analysing their tools and the tool marks of the objects we will be getting an idea how the skills of the craftsmen developed and how the transfer of knowledge worked. Objects from this early period in Northern Europe are rare. In using the supplies of the Archaeological State Museum Gottorf Castle in Schleswig we have access to a wide range of objects dating 3500 to 1200 BC, the most important period for the development of metallurgy.
In 2005 several new stone tools were found in the Archaeological State Museum and together with Barbara Armbruster from the CNRS Toulouse a research project “Stone tools for metal working” was started. The focus of the analysis was laid on the function of the tools and the process of metal working [1, 2]. Previous experiments [3, 4] have shown the general feasibility of using SR XRD to phase analyse bronze artefacts in order to understand their manufacturing and place of origin.

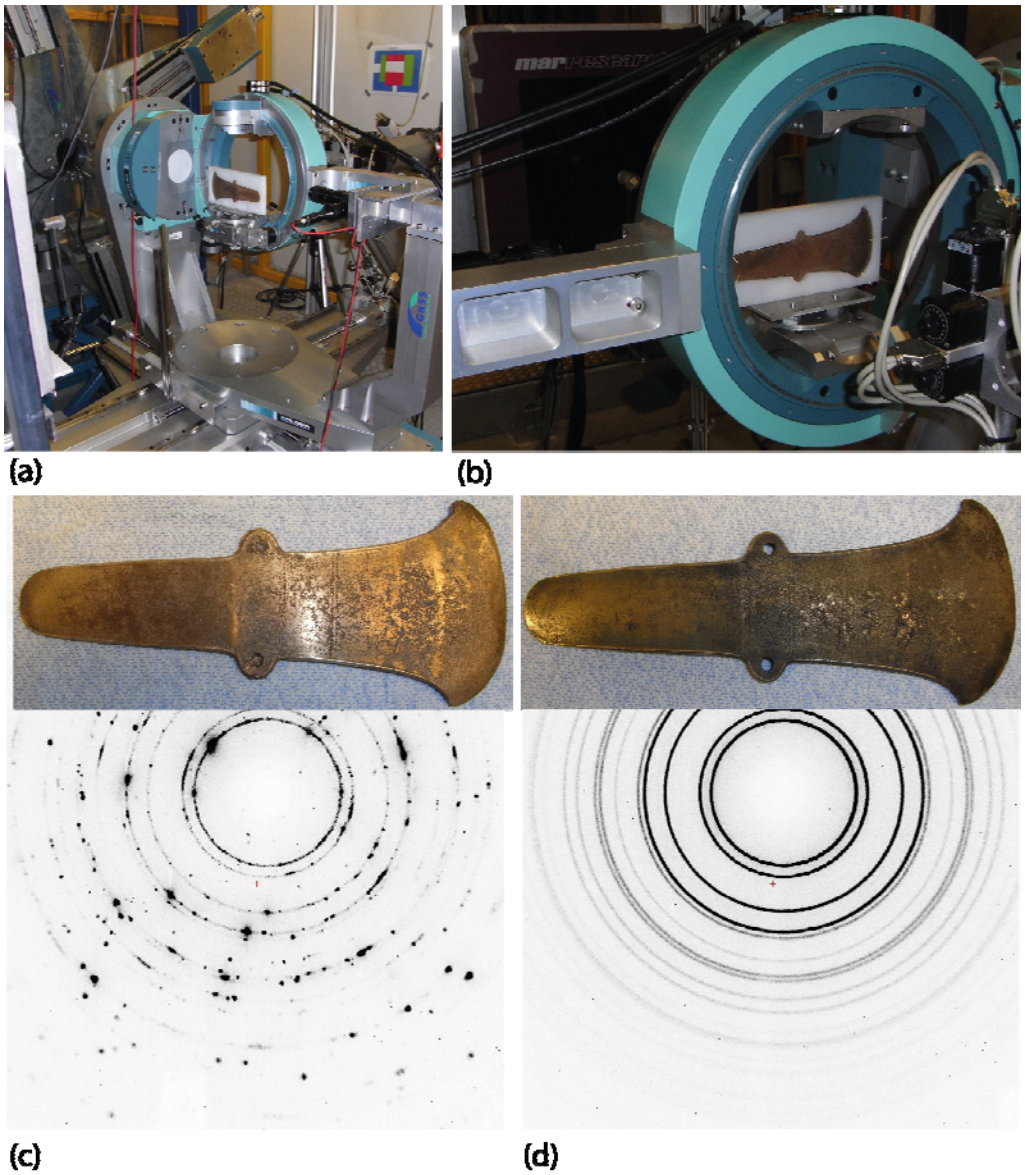

Figure 1: (a+b) The axe in the diffractometer at HARWI. (c) The replica and the diffraction pattern of the replicated axe that was heated and forged after the casting process. (d) The Axe of Ahneby (4000 years old) and the corresponding diffraction pattern.

With a set of reproduced tools we made some replicas of the axe from the late Neolithic axe from Ahneby using the same alloy but used different techniques to find out how the surfaces of the objects could be smoothed after casting. At one axe the casting flaws and the surface were smoothed out by hammering at another one they were polished out with flint blades and a whetstone.

To compare the bulk structure of the ancient objects with our replicated samples, we performed some test diffraction measurements for phase analysis at the W2 Beamline HARWI at DORIS. The measurements were done using a 101 keV photon beam of 1 mm^2 spot size and a Mar CCD 555 detector (pixel size 139x139 μm^2) positioned 1.5 m behind the objects.

These diffraction measurements have shown strong differences between the ancient bronze objects and all of our modern replicas. Obviously the grain structure of the historic objects is much finer and smoother, while the modern replicas show many strong diffraction spots belonging to large grains. New replicas will be cast with slightly modified bronze in May and September 2011 and treated with heat and stone tools in various ways during and after the casting process.

Further investigations are planned in order to understand and reproduce the historic way of the crafting of bronze artefacts.

References

[1] M. Freudenberg, Cushion Stones and other Stone Tools for early Metalworking in Schleswig-Holstein. Some new Aspects on local Bronze Age Society., in: F.B. L. Astruc, V. Lea, P.-Y. Milcent, S. Philibert (Ed.), Normes techniques et pratiques sociales: de la simplicité des outillages pré- et protohistoriques, Antibes (2006) 313-320.

[2] M. Freudenberg, Steingeräte zur Metallbearbeitung - Einige neue Aspekte zum spätneolithischen und frühbronzezeitlichen Metallhandwerk vor dem Hintergrund des schleswig-holsteinischen Fundmaterials, Archäologisches Korrespondenzblatt 39 (2009) 341-359.

[3] Friedman et al., *Synchrotron-Strahlung-Based X-ray Analyse der Bronze-Artefakte aus der Eisenzeit Standort in der judäischen Hills*, Journal of Archaeological Science, Band 35, Heft 7, Juli 2008, Seiten 1951-1960.

[4] H. Klein et al., *Non-destructive Phase Analysis of Historical Objects of Art*, HASYLAB Jahresbericht 2007, pg. 1595-1596.