Surface diffraction investigations on neolithic bronze axes and replicas

L. Glaser[a],J. Donges[a] and M. Freudenberg[b]

[a] HASYLAB / DESY, Notkestr. 85, D-22607 Hamburg, Germany

[b] Stiftung Schleswig-Holsteinische Landesmuseen, Schloß Gottorf, D-24837 Schleswig, Germany

The first metal objects can be dated into the fourth millennium BC in the North. During the third millennium the craftsmen started experimenting with different alloys and tools. The first and almost only analysis of early tools for metal working was made in the Netherlands during the sixties. In 2005 several new tools were found in the Archaeological State Museum Gottorf Castle and together with Barbara Armbruster from the CNRS Toulouse a research project “Stone tools for metal working” has been started. The focus of the analysis was laid on the function of the tools and the process of metal working [1, 2]. The process of casting is quite well known, what we are still lacking are some details of the casting process and the knowledge about the treatment of the surfaces, of hardening of the edges and how the stone tools were used in this process.

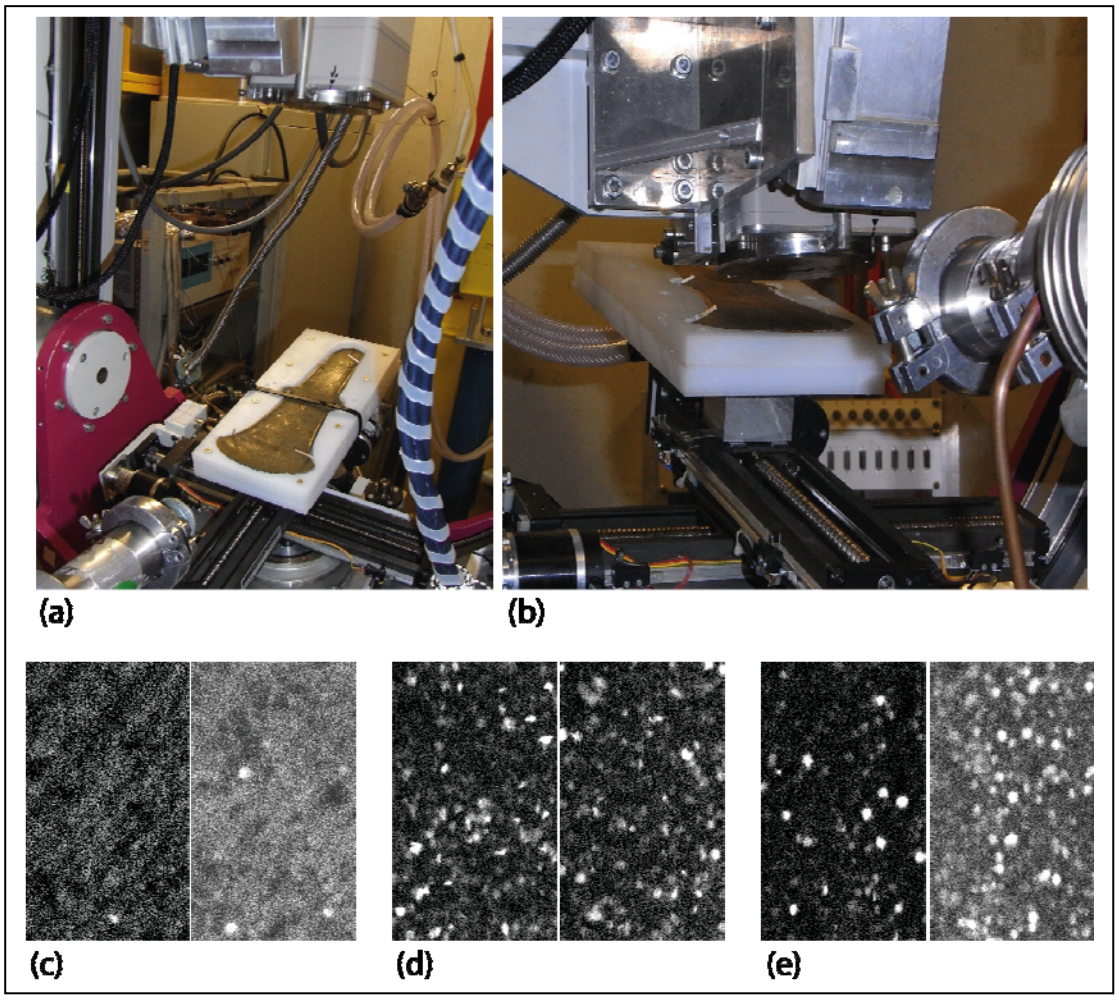

Figure 1: (a+b) The 4000 year old Axe of Ahneby at Beamline G3. (c) The surface bragg reflex pictures of a cast untreated replica. (d) The pictures of bragg reflexes of a replica forged 3 times. (e) The bragg reflex picture of the original 4000 year old axe**.**

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.

One of the big archaeological questions still is if, how and when the ancient smiths used stone tools to further treat the cast bronze objects. In a first step we compared the differently surface treated modern replicas with the ancient object. At the G3 Beamline at DORIS we used the installed CCD camera with a micro channel plate collimator, to take position sensitive pictures of the bragg reflections of the surface of the bronze objects. The incoming beam had an energy of 5.9 keV, the investigated surface spot was 1 cm^2, while the spatial resolution of the detector was about 12 µm, thus we measured the grain structure of several objects surface sensitively.
These first test experiments at G3 have shown, that the surface of our replicated axes if forged with stone tools and heated several times the replicas show a similar pattern as displayed by the historic axe of Ahneby. At this time it is not clear whether the heating or the stone tool treatment have the desired effect or if the combination is necessary. Further investigations of the surface structures of historic bronze axes may surely be helpful in the future to answer the question of the use of stone tools in the production process, after some other differences between the original axe and the replicas could be reduced, which turned up at measurements at W2 and P07.

References

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[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.