DEVELOPING A NEW SUBSTITUTE FOR IVORY USING LITHOGRAPHY BASED ADDITIVE MANUFACTURING

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INTRODUCTION

Due to its convenient mechanic workability and general popularity, ivory was used for art, religious and everyday objects for hundreds of years. Nowadays the resources are limited due to the ivory trading ban, which was set in place for ethical reasons. The price of legally available ivory from remaining stocks is, therefore, very high. The wish to restore sometimes very fragile and delicate cultural artefacts, thus, requires the development of a high-quality substitute material. Most of all, it is necessary to replicate the aesthetic characteristics of ivory by means of the color, translucency and haptic. This also includes the recreation of in ivory specific pattern, which is especially visible at the cross-section of an elephant tusk, as shown in Figure 1. This pattern is also called Schreger lines.

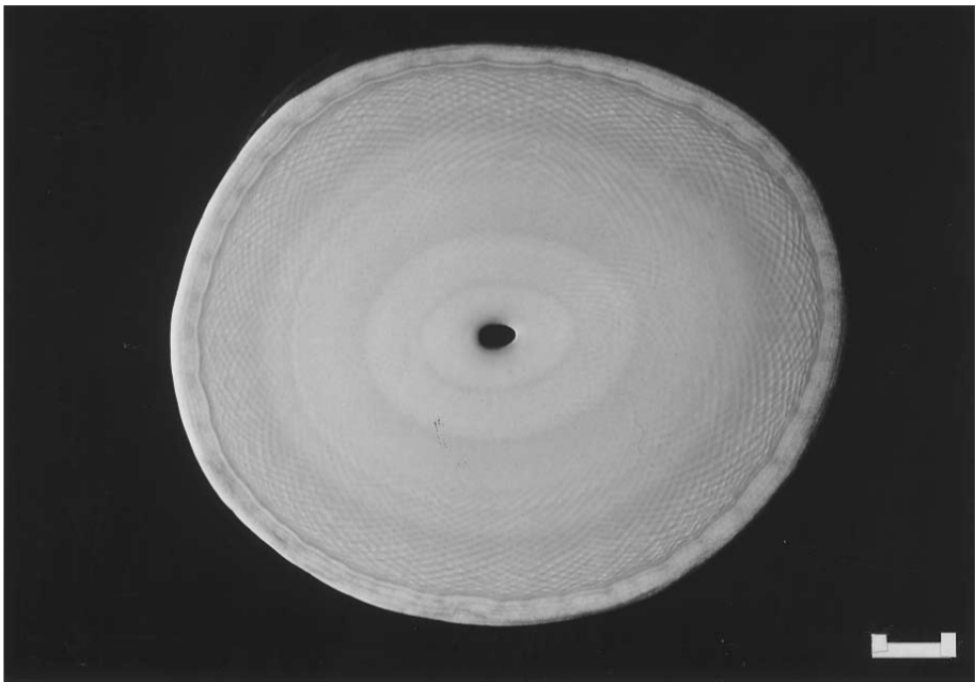

Figure 1:Crosssection of an elephant tusk with Schreger lines visible. The scaling bar equals 4 cm[1].

METHODS

Ivory consists of an organic matrix with embedded calcium phosphate and carbonate. To imitate the morphology a composite was formed, consisting of a photopolymer filled with calcium phosphate particles. In addition, color pigments were mixed into the compound to adjust the base color. In order to remodel the column capital of the cabinet of king Friederick the Fair, micro computed tomography was utilized. A computer-aided design program was used to apply a surface texture that imitates the appearance of the Schreger lines. The model was then sliced into 0.5 µm thick layers. The composite was solidified using lithography based additive manufacturing and, subsequently, the surface was dyed and polished.

RESULTS

Choosing a degree of filling of 55 wt-% calcium phosphate, the Young's modulus, the density and the translucency of the material are comparable to natural ivory. The generation of the surface texture is a simple way to mimic the Schreger lines. However, further post processing of the surface is necessary for an optical imitation of ivory. Figure 2 shows the column capital of the cabinet of king Friederick the Fair, recreated by additive manufacturing compared to the original artefact.

Figure 2: Comparison of the manufactured (left) and the original (right) column capital of the cabinet of king Friederick the Fair.

CONCLUSIONS

Considering the cost, time and ethical aspects it is reasonable to use a substitute material for restoring ivory artefacts. Since the building technology is additive manufacturing, also individual and detailed geometries are possible. This new solution for substituting ivory shows promising results and advantages over existing substitute materials.

REFERENCES

[1] Raubenheimer EJ, Bosman MC, Vorster R, Noffke CE, Histogenesis of the chequered pattern of ivory of African elephant (Loxodonta Afircana), Archives of Oral Biology, 43:6, 969-977, 1998