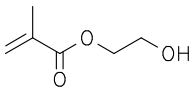
The Restoration of the Terracotta Army of the First Chinese Emperor: A Chemical Challenge

Heinz Langhals

LMU University of Munich, Department of Chemistry,
Butenandtstr. 13, D-81377 Munich, Germany

The terracotta army of the first Chinese emperor Qin Shihuangdi was found during the construction of wells in Lintong approximately 30 km east of the provincial capital Xi'an ("western peace"), in 1974. It is clear in the meantime that the archaeological field covers an area of at least 4 x 4.5 km. The field comprises more than 100 single pits and is probably the largest archaeological find worldwide. More than 1500 life-sized terracotta warriors have been excavated and restored until now. Many statues of animals such as life-sized horses and 7000 to 8000 separate statues are estimated in the already opened pits. Moreover, complete war-chariots with terracotta horses were excavated. However, soon after the first excavations it became clear that this was not only an extraordinary archaeological find, but also a special conservation and restoration challenge because the terracotta warriors and animals were initially polychromed. They lose their colouration soon after excavation.

秦



HEMA

The conservation of the polychromy represents a special problem because of the deterioration of the ground layer consisting of organic material. This was triggered due to it having spent more than 2200 years in water-saturated soil. The consolidation of the polychromy was achieved through the polymerisation of a specially adapted combination of monomers containing HEMA as the major component and applying electron beam polymerisation. Novel monomers were developed for electron beam curing and individually combined for the special requirements of consolidation of excavated findings in archaeology.

References:
[1] H. Langhals, *Nachr. Chem.* **2009**, *57*, 1079-1084.
[2] H. Langhals, B. Oginski, *J. Polymer Sc. Part A: Polymer Chemistry* **2008**, *46*, 6660-6663.
[3] H. Langhals, D. Bathelt, S. Bucher, *Chemie in unserer Zeit* **2005**, *39*, 196-211; *Chem. Abstr.* **2005**, *143*, 172244.
[4] H. Langhals, D. Bathelt, *Angew. Chem.* **2003**, *115*, 5854-5859; *Angew. Chem. Int. Ed. Engl.* **2003**, *42*, 5676-5681.
[5] I. Rogner, H. Langhals, Zhou Tie, Zhang Zhijun, Rong Bo, C. Blänsdorf, C. Herm, 'Consolidation and preservation of the polychrome qi-lacquer layers of the terracotta army of Quin Shihuang by treatment with methacrylic monomers and electron beam curing' in *The terracotta army of the first chinese emperor Quin Shihuang*, *Arbeitshefte des Bayerischen Landesamtes für Denkmalpflege*, **2001**, *83*, 594-617; ISBN 3-87490-711-2.