

# 21st century technology cracks alchemists' secret recipe

**A 500-year old mystery surrounding the centerpiece of the alchemists' lab kit has been solved by UCL (University College London) and Cardiff University archaeologists.**

Since the Middle Ages, mixing vessels – or crucibles – manufactured in the Hesse region of Germany have been world renowned because of their ability to withstand strong reagents and high temperatures.

Previous work by the team has shown that Hessian crucibles have been found in archaeological sites across the world, including Scandinavia, Central Europe, Spain, Portugal, the UK, and even colonial America. At the time, many people tried to reproduce them but always failed.

Now, writing in *Nature*, the researchers reveal using petrographic, chemical and X-ray diffraction analysis that Hessian crucible makers made use of an advanced material only properly identified and named in the 20th century.

Dr Marcos Martín-Torres, of the UCL Institute of Archaeology, who led the study, explains: "Our analysis of 50 Hessian and non-Hessian crucibles revealed that the secret component in their manufacture is an aluminium silicate known as mullite ( $\text{Al}_6\text{Si}_2\text{O}_{13}$ ).

"Today mullite is used in a wide range of modern conventional and advanced ceramics, such as building materials, electronic packaging devices, optical materials and catalytic converters, as well as in ceramic matrix composites such as thermal protection systems and liners for aircraft and stationary gas turbine engines.

"This material was only first described in the 20th century, though Hessian crucible makers were already taking advantage of this peculiar aluminium silicate 400 years earlier: they synthesised mullite by manufacturing their crucibles with kaolinitic clay and then firing them at temperatures above 1100 degrees.

"Mullite is extremely resistant to thermal, chemical and mechanical stresses, and that's what made the crucibles so fit for their functions. It is thanks to the availability of Hessian crucibles that the discovery of some elements and their thermochemical behaviour could take place.

"Crucible makers were not aware of mullite, but they mastered a very successful recipe, and that's why they kept it constant, and secret, for centuries."

Professor Ian Freestone, Cardiff School of History and Archaeology, said: "Manufacture of the crucibles used in early metallurgy and alchemy challenged the potters as they were required to withstand conditions more extreme than those required of other ceramics. In this case we find that the properties of a material which we regard as modern and high-tech, in this case mullite, were being exploited centuries ago by craftsmen who had a limited scientific understanding of their products but a great deal of skill and ingenuity."

Source: University College London

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