Researchers develop pioneering X-ray technique to analyze ancient artifacts

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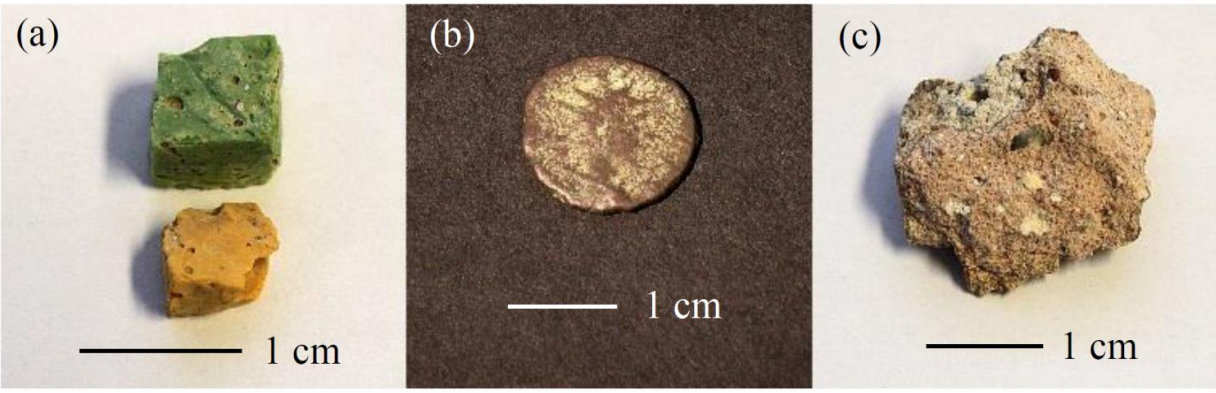


Photographs of the archaeology samples. Credit: University of Leicester

A pioneering X-ray technique that can analyse artefacts of any shape or texture in a non-destructive way has been developed by an international team of researchers led by the University of Leicester.

The technique, which has been showcased in a paper published in the journal *Acta Crystallographica A*, uses X-ray diffraction (XRD) in order to determine crystallographic phase information in artefacts with very high accuracy and without causing damage to the object being scanned.

Using the technique, researchers can identify pigments in paintings and on painted objects - which could potentially be applied in the future to

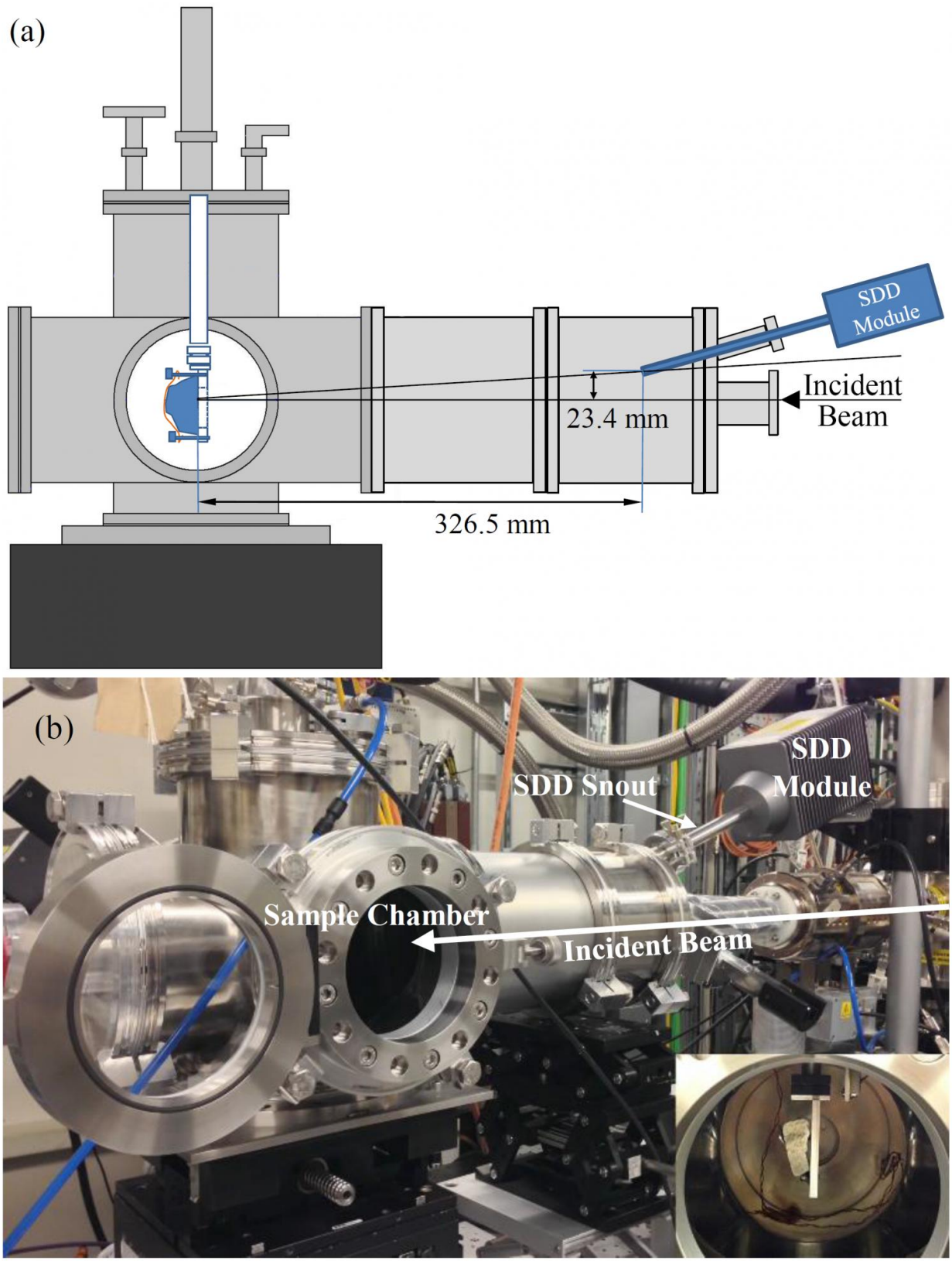
help to clamp down on counterfeit artwork and artefacts and verify authenticity.

The research suggests that the non-invasive technique could also eliminate the frequent need to compromise between archaeological questions that can be solved and the analytical methods available to do so.

Dr Graeme Hansford, from the University of Leicester's Department of Physics and Astronomy, explained: "The ability to do high-quality non-destructive XRD analysis of cultural heritage artefacts is very exciting for me and represents the culmination of several years of work.

"What makes this method really unique is that the shape and texture of the sample become immaterial. I expect future studies to make significant contributions to determining the provenance of a range of archaeological objects, and this data will ultimately provide vital context information for museum collections.

"In paintings, the type of pigment used frequently yields useful insights into methods of production and the organisation of ancient industries, as well as restricting the possible date of manufacture. This could help to determine if the provenance of an artefact is as purported."


(a)
SDD Module
Incident Beam
23.4 mm
326.5 mm
(b)
SDD Snout
SDD Module
Sample Chamber
Incident Beam

Credit: Diamond Light Source

The development of the novel XRD technique is being led by Dr Hansford, along with Dr Stuart Turner (a Leicester PhD student at the time of the research) and Professors Andrew Shortland (Centre for Archaeological and Forensic Analysis, Cranfield University) and Patrick Degryse (Centre for Archaeological Science, K.U. Leuven, Belgium).

The novel technique is insensitive to the shape of the sample, tolerating even markedly non-planar and textured surfaces.

Consequently, it can be applied with no preparation of the sample at all and so is completely non-destructive, in contrast to conventional XRD methods.

These characteristics are ideal for the analysis of cultural heritage and archaeological artefacts for which maintaining the object integrity is of paramount importance.

The efficacy of the XRD technique has recently been proven in a high-resolution configuration at the Diamond Light Source synchrotron. A synchrotron produces highly intense beams of light, primarily X-rays, which can be used to probe matter in a wide variety of ways.

The UK's Diamond Light Source is a national, state-of-the-art synchrotron facility situated on the Harwell Science and Innovation Campus in Oxfordshire.

Professor Andrew Shortland, from the Centre for Archaeological and Forensic Analysis at Cranfield University, said: "Archaeological scientists are continually aware that taking samples for analysis from rare

and historical objects has to be minimised, or better still eliminated altogether. This new non-destructive technique has the potential to open novel lines of research and answer new questions about our most valuable and interesting historical and archaeological objects. Cranfield University is very happy to play a part in such an important project."

Professor Patrick Degryse from the Centre for Archaeological Science, K.U. Leuven, Belgium, said: "In a museum context, the development of new, accurate means of non-invasive analysis is an absolute necessity. It is often the only approach tolerated by curators. In an archaeological context, portable and non-destructive in-situ techniques, immediately applicable in the field, are required. These avoid sampling, leave the artefact untouched, and abide by often strict export restrictions."

More information: 'High-resolution X-ray diffraction with no sample preparation', *Acta Crystallographica A*, DOI: 10.1107/S2053273317008592

Provided by University of Leicester