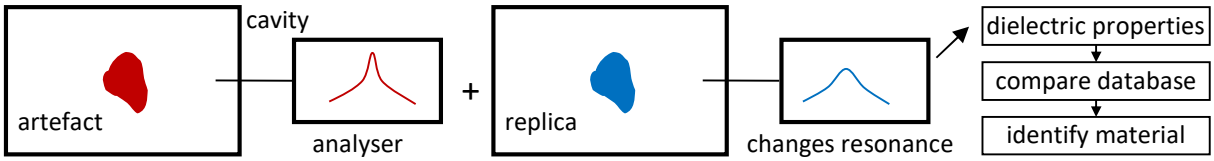
Dielectric Replica Measurement: A Non-Destructive Technique for Object Identification in Archaeology and other Fields

Support for Proposal to EPSRC for a Collaborative Research Project

We are a group of researchers at the **University of York** seeking support for a grant application to develop our new method of identifying dielectric (insulating) materials, called DRM. Dr Martin Robinson and Dr John Dawson are in the Dept of Electrical Engineering and have many years' experience in applied electromagnetics and material measurements, while Dr Steve Ashby, Dr Laura Fitton, Dr Aimée Little and Dr Sam Cobb are in the Dept of Archaeology, some with links to Hull York Medical School, and have complementary expertise in 3D scanning and printing, as well as identification of archaeological artefacts.

Dielectric Replica Measurement (DRM) uses low power radio waves confined in an enclosure, and is thus safe and non-destructive. The enclosure forms a resonant cavity whose frequency and Q-factor depend on the complex permittivity of the sample. Both real and imaginary parts of this quantity give us useful and different information, helping us to identify the material. Traditional cavity perturbation measurements are also influenced by the sample shape, but we eliminate this factor by creating a 3D-printed replica of the sample for a 'bespoke' calibration of each measurement.



We propose to build on our successful pilot experiments reported recently [M P Robinson et al. 2019, *Meas. Sci. Technol.* **30** 045902] to enhance and improve the measurement, and to apply it to practical problems. These include (1) **archaeological**: the characterisation and biogeographical provenancing of raw materials, such as ceramics, glass, or flints and cherts, with a view to academic questions about long-range trade, population movement, and culture contact, (2) **conservation science**: the rapid and reliable identification of raw materials ahead of determining conservation strategies in museums and archives, as correct identification is vital to designing storage and display facilities in terms of humidity and other environmental conditions, and (3) **forensic**: a test to verify material origin could be used by customs officers to distinguish, for example, elephant ivory from bone or teeth of other species, to prevent cross-border smuggling.

We are seeking **letters of support** for our proposal from institutions and bodies that would benefit from our research findings. Specifically we are asking for (a) practical advice: we intend to set up an expert panel of stakeholders to ensure relevance and maximise impact, (b) loan of objects for samples to test by DRM: non-metallic, e.g. flint, ceramics, glass, amber, bone, antler ,ivory etc., ideally up to a few cm in size and up to 10g mass, and (c) help with demonstrating the final measurement system to end users, the academic community and the general public.

For more details please contact:

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