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Combinatorial synthesis of piezoelectric materials using an inkjet printer

Piezoelectrics are used in a wide variety of technology applications and currently their best performing compositions are lead-based. Legislative requirements will impose serious restrictions on the use of these lead-based materials in consumer devices over the coming years and currently no viable lead-free alternative exists. A potential pathway for the discovery of such a unique material is through combinatorial techniques. Combinatorial chemistry is the rapid synthesis and analysis of large numbers of compositions, through many combinations of a relatively small number of starting compounds.

Inkjet printing is currently at the threshold of becoming a standard fabrication tool, with a wide range of materials science applications. It is regarded as one of the most promising techniques for the creation of functional metal oxides on various substrates because it has an automatically controlled printing scheme with precise and flexible droplet volumes and offers rapid mass production. This project aims to produce a ternary phase diagram with a compositional resolution of 1% using ceramic suspensions and inkjet printing technologies.

This study outlines the challenges and methods for producing high quality ceramic inks. Using rapid, high energy milling techniques, ceramic inks with a maximum particle size of 200 nm have been developed. This has been used to print single phase Barium Titanate on Alumina substrates using a commercial printer.

This technique has the potential to lead to the development of novel environmentally-friendly lead-free compositions of piezoelectrics and a state-of-the-art combinatorial synthesis technique for functional materials discovery.

Primary author(s) : Mr MARLTON, Frederick (Student)

Co-author(s) : Dr DANIELS, John (UNSW); Dr STANDARD, Owen (UNSW)

Presenter(s) : Mr MARLTON, Frederick (Student)