Researchers identify greater environmental risks in 'green' material

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Professors Ian Reaney, Department of Materials Science and Engineering, and Lenny Koh, Management School, undertook the first comparative life cycle analysis of piezoelectric materials as part of an EPSRC project. Their findings indicate that a replacement for lead zirconate titanate (PZN), recommended by global authorities due to its green credentials, is more dangerous to the environment.

The mining and production process for the recommended replacement, potassium sodium niobate (KNN), releases heavy metals and radioactive materials and has a significant adverse effect on air quality, water quality and the land. By applying life cycle analysis to both materials, the team were able to identify that harmful effects of KNN took hold on the environment prior to using the material - the damage was done before it even reached manufacturers meaning that EU legislators could have been unaware of its implications.

These findings will have a significant impact on global policy and the manufacturing sector. Piezoelectric materials are used in a wide array of products and projects including sensors, military hardware, generators and smart structures - global demand for the material is estimate at $1billion with an annual growth rate ten per cent.

Professor Lenny Koh, co-investigator on the research, said: "Our findings demonstrate the pivotal role of life cycle analysis in determining the environmental sustainability of substitutions of materials. Materials scientists, engineers and industry must consider the life cycle impact of

materials in design and manufacture before deciding on the preferred substituted choice. Legislative bodies play a leading role in enforcing such responsibility in order to protect the scarcity and criticality of materials resources and prevent unsustainable practices."

The main findings of this study were recently published by the Royal Society of Chemistry in the *Energy and Environmental Science* Journal. Lead author on the paper, Dr Taofeeq Ibn-Mohammed, is an ESPRC research associate and works with Professor Koh at two centres linked with the Management School, the Advanced Resource Efficiency Centre and the Centre for Energy, Environment and Sustainability. Of the work, he said: "Overall, the research demonstrates that application of life cycle analysis and supply chain management to a strategic engineering question allows industries and policy makers to make informed decisions regarding the environmental consequences of substitute materials, designs, fabrication processes and usage."

Professor Reaney, principal investigator on the project, concluded: "The research has strong implications for future legislation concerning piezoelectrics within the European Union and worldwide."

More information: T. Ibn-Mohammed et al, Integrated hybrid life cycle assessment and supply chain environmental profile evaluations of lead-based (lead zirconate titanate) versus lead-free (potassium sodium niobate) piezoelectric ceramics, *Energy Environ. Sci.* (2016). DOI: 10.1039/C6EE02429G

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