Piezo Institute researchers have developed an environmentally-friendly technique, PCSD, to minimise lead loss in the production of piezoceramic thin films.

Lead is used in piezoelectric compounds because it results in high spontaneous polarisation and electromechanical activity. However, recent European Directives promote the production of environmentally friendly piezoceramics, where the use of lead is minimised.

Developing lead-free piezoceramics with similar performances to lead-based components is therefore a key area of focus for the Piezo Institute.

The problem with piezoceramics

Piezoceramic production traditionally requires a very high annealing temperature – well above 800 °C. This is the level at which lead oxide becomes gas and is irreversibly lost. This loss adversely affects the performance of the material. Excess lead oxide (up to 30% over the desired composition) is added to compensate for the lead that will be lost through volatilisation.

Production of thin films using chemical solution deposition (CSD) methods also requires high temperature thermal processing. This removes residual organics before crystallisation of the piezoceramic film.

The solution

Piezo Institute researchers have developed a chemical deposition technique called PhotoChemical Solution Deposition (PCSD) for ferroelectric thin film production. With PCSD a thermal processing temperature of 450 °C can be used to obtain high performance films, avoiding lead oxide loss. This removes the need for a lead oxide excess.

PCSD is an ultraviolet assisted sol-gel annealing technique. The photocatalyst for the fabrication of sol-gel piezoelectric thin films is the UV-irradiation system. A laboratory-scale ultraviolet-assisted processor for the fabrication of sol-gel piezoelectric thin films is placed in between the Infrared lamps heating system (A) and the UV-irradiation system (B). (ICMM)

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Other benefits

Microelectronic devices cannot tolerate the high temperatures used in traditional piezo processing. Interdiffusion and contamination of component elements takes place, resulting in loss of the microelectronic properties. Integrating piezoelectric thin films with microelectronics components has therefore been a problem.

"The reduced temperature and time required by PCSD is low enough for microelectronic devices to retain their properties," says Prof Lorena Pardo from Instituto de Ciencia de Materiales de Madrid (ICMM), an associated member of the Piezo Institute. "This makes it possible to integrate piezoceramics with microelectronics."

"We're also continuing to try to reduce the amount of lead used in piezocompounds," says Pardo. "Our aim is to obtain an integrated and environmentally-friendly piezoelectric component."


Extra info

PhotoChemical Solution Deposition (PCSD) for production of ferroelectric thin films was developed at ICMM, an associated member of the Piezo Institute, in cooperation within the European project on Microfabrication with Ultraviolet Assisted Sol-gel Technology.
Piezo Institute features in the International Herald Tribune

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Piezo Institute partner project reported in The Engineer

Piezo Institute in the Financial Times

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