# Materials Advances: Holey Ceramics

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Unique material is designed by Rostov scientists supported by the Russian Foundation for Basic Research (RFBR) and Foundation for Assistance to Small Innovative Enterprises (FASIE). This is a porous ceramic for a piezotransformer that is the 'heart' of any ultrasound diagnostic device. The new material makes it possible to replace expensive heavy equipment by compact portable devices providing the same quality of diagnostics.
It was unfair to list dead donkey ears and doughnuts' holes among most useless things, as did Ostap Bender in the famous novel 'Twelve Chairs'. The former concept found its use in Viktor Pelevin story, and the latter in figurative sense was used by Russian scientists.

The team from the Research Institute of Physics (Rostov) designed and obtained a unique material - a porous ceramic. It was established that having a certain number of holes of certain size and shape considerably improves the quality of material for transformers in medical ultrasound diagnostic equipment. And portable devices with new type transformers will be as powerful as massive stationary equipment now.

The piezoelectric transformer is a most important part of any ultrasound diagnostic device. The transformer properties predetermine the principal characteristics of the device: the depth and size of diagnosable objects and the precision of diagnostics. Indeed, the prenatal diagnostic of a baby's sex is not the same task as locating a formation of several millimetres in size.

Provided that other parameters are similar, the sensitivity of ultrasound

diagnostic equipment is determined by the qualities of its piezotransformer material. The piezotransformer generates ultrasound and receives reflected waves. The latter gives us information about a certain object of the patient's body that is displayed on a screen.

Piezoelectric transformers for ultrasound diagnostic equipment are usually made of ceramics, either homogeneous or heterogeneous. The former is solidified solution of lead zirconate-titanate. The latter consists also of lead zirconate-titanate with embedded particles of another material.

The team of Rostov specialists headed by Dr. Evgeny Tsikhotsky developed a principally new approach. They designed piezoelectric materials on the basis of porous ceramics. In transformers made in Rostov, the matrix of lead zirconate-titanate includes, instead of grains of other ceramic or polymer material, just doughnuts' holes, as we can figuratively call pores and voids.

Of course, that material is a more difficult to make than, e.g., porous chocolate. Firstly, complex mathematical operations were necessary to find appropriate size, shape, density, and distribution pattern of pores. These parameters determine piezoelectric properties of the porous ceramic, which can be improved in a certain way or degrade or even disappear. Secondly, after establishing the optimal parameters of porosity, it was necessary to develop a special technique for synthesis of such ceramics.

The team of Evgeny Tsikhotsky have accomplished the both tasks, though they have some reservation in revealing technical details. Now they need to obtain a patent on this invention. And they believe that new materials still need some improvement. But it is time already to tell about potential advantages of using porous ceramics. Leading specialist Dr. Valery Smotrakov gave us the following comment: "Our porous

piezoelectric ceramic will double the sensitivity and resolution of ultrasound diagnostic equipment. Portable devices will be as powerful in diagnostics as modern stationary equipment. Portable scanners today have resolution of only 3.5-5 mm, but it can reach 2 mm with the use new type transformers on the basis of porous ceramics."

An apparatus with a new type transformer will appear not very soon. The properties of obtained piezoelectric material should be improved, as believe the inventors. However, they plan to make first trial models of ultrasound gauges based on porous ceramics by the end of this year.

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