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Designing advanced piezoelectric ceramics for novel ultrasonic applications

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As new applications of medical ultrasound continue to emerge and the development of electronics continues, there is an increased interest in specialised piezoelectric ceramics with optimised properties. With the present level of knowledge about piezoceramics it is possible to design materials combining selected characteristics - although of course the laws of physics prevent changing certain properties independently. The main parameters in the design process are composition modification and controlled porosity. One of the new types of materials developed is especially intended for high-intensity focused ultrasound (HIFU) applications, where the ability to continuously generate high acoustic power should be combined with specifications for electrical impedance matching. Since the first requirement calls for very low dielectric and mechanical losses (hard doping), whereas for typical applications the second one calls for a high permittivity (soft material), a new combination was needed. The new PZT-based materials Ferroperm Pz52 and Pz54 fulfil these requirements and are already being extensively used for HIFU applications. Another example of new materials is the commercial family of porous PZT. The introduction of porosity affects all properties, and by optimising composition and porosity level it is possible to design materials that can replace lead metaniobate-based ceramics for a number of applications.