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Physics and Politics in the Development of Lead-free Piezoceramics

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While the traditional materials of choice for piezoelectric devices over the past 60 years were lead-based perovskite ceramics, the environmental- and health-concerns, supported by governmental regulations, triggered the search for new lead-free alternatives [1]. This is embedded into a view of annual usage of lead as compared to other metals and the efforts to reduce lead in various commercial products in the last decades. During the past 10 years the research output rose from 10 to 400 publications per year with China and Japan leading, Europe accounting for 10 % of the total quantity and the US only showing very select activities.

In addition, a number of companies invested large sums into research and they aim at solid financial return. Some of them produced material reproducibly in 100 kg batches and select areas were identified, where lead-free piezoceramics have an advantage to lead-containing piezoceramics. As a result, the first products started to appear at the market place.

The aim of this contributions is to review the global situation and present scientific challenges and advancements, which have been made by introducing the three main competitors based on different chemistry and different salient phase diagrams. I will highlight achievements and remaining challenges in physics and will point to fruitful fields for the near future [2].

[1] Jürgen Rödel, Wook Jo, Klaus Seifert, Eva-Maria Anton, Torsten Granzow and Dragan Damjanovic, "Perspective on the Development of Lead-Free Piezoceramics", J. Amer. Ceram. Soc., 92 [6] 1153-1177 (2009)

[2] J. Rödel, K.G. Webber, R. Dittmer, W. Jo, M. Kimura and D. Damjanovic, „Transferring lead-free piezoceramics into application", J. Eur. Ceram. Soc., 35, 1659-81 (2015)

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