Printable piezoelectric films – acoustic transducers, energy harvesting and flexible sensors

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Printable piezoelectric materials have been under development over the recent years due to their great potential in several fields of application, covering both low- and high-frequency devices. CTS | Ferroperm has been one of the players in the field through its development of a screen- and pad-printable PZT thick film material (TF2100) as well as the composite material PiezoPaint™. Printable PZT thick films have already been successfully commercialized; however the process of screen printing of PZT thick films involves potential problems of thermal matching and chemical compatibility at the processing temperatures between the functional film, the substrate and the electrodes, which will be further discussed in the paper.

The present paper is summarizing the properties as well as presenting several applications of printable piezoelectric materials. Within the field of high-frequency ultrasound, a new technology for fabrication of devices working at higher frequencies is presented, which is suitable for production in large numbers at a low cost. This technique has been used to produce single-element high-frequency ultrasonic transducers in the past; however it has been shown recently that it can also be successfully applied for fabrication of multi-element devices.

Furthermore, the TF2100 composition exhibits good resistance to reactive substrates such as silicon, stainless steel and alumina. It has also been studied as a potential fabrication technology of energy harvesting devices due to its compatibility with MEMS processes. This paper is summarizing the properties and parameters of millimeter-scale vibration energy harvesting devices. It has been shown that a 10x10 mm^2 device is capable of producing 40 µW of continuous power at accelerations as low as 0.3 *g*, when excited at its resonance frequency.

The recently introduced printable PiezoPaint™ material is substantially different to TF2100, due to drastically reduced processing temperature (100°C vs. more than 800°C). Due to this fact PiezoPaint™ is compatible with several different substrate materials, such as polymer, metal, paper, textile etc. Therefore it is potentially attractive in many different fields of application. Here a printed motion sensor device is presented in order to illustrate the capabilities of PiezoPaint™ technology.

Printable piezoelectric materials have already found their way to the market in very few niche applications. This indicates a great commercial potential in future products. It is expected that medical as well as sensor markets will benefit the most from the printed piezoelectric, however the successful product development has to be carried out with the involvement of not only the technology providers but also the application leaders.