

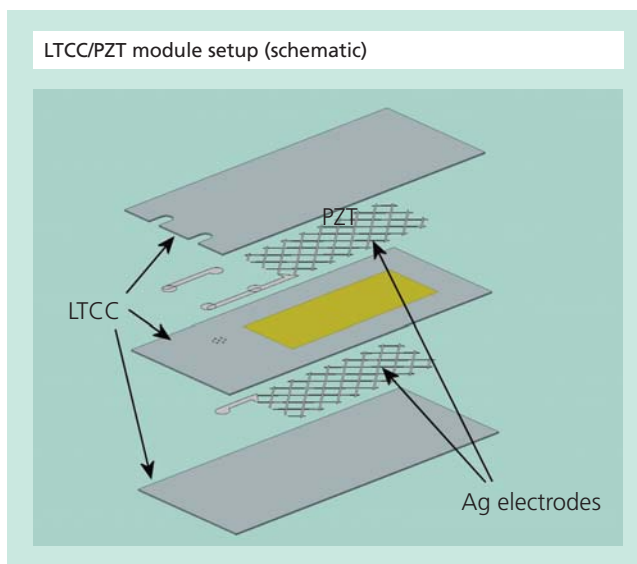
ROBUST SENSOR / ACTUATOR MODULES BASED ON LTCC / PZT LAMINATES

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Adaptronic components use integrated sensors and actuators in combination with adjusted electronics for controlling and regulating the structural dynamic properties such as vibration damping or noise suppression. The direct integration of sensors and actuators in metal structural components requires the development of robust sensor/actuator modules which can withstand the harsh conditions of the metal shaping process step (e.g. die casting) without defects, and which are electrically insulated against the metal matrix. Such modules were successfully developed by integrating PZT plates in LTCC (Low Temperature Cofired Ceramic) multilayer structures. This approach combines LTCC microsystem technology and piezotechnology and allows for a combination of the advantages of both systems like 3D wiring, complex shaping and integration of electronic components, sensors, actuators as well as ultrasound transducers.

The novel piezolayer technology uses sintered PZT (lead-zirconate-titanate) plates which are laminated with LTCC green tapes and subsequently heat treated (see diagram). It is the challenge to avoid stress cracks in the LTCC during shrinkage on the already sintered PZT material. This can be realized with a LTCC material which has an anisotropic shrinkage behavior. The technology allows to mechanically stabilize and to electrically insulate the piezoceramic part in the module. Internal wiring is guaranteed by vias and Ag conducting paths which are applied through screen printing. According to the field of application the modules exist of three to eight LTCC layers which are laminated and isostatically pressed with each other. Then, the parts are green machined to obtain final size and sintered applying uniaxial pressure. The so produced sensor/actuator modules were successfully integrated into thin-walled aluminum compo-

nents by metal die casting within the DFG project SFB/TR 39 "PT-PIESA". A false-color X-ray image of a metal plate with integrated LTCC/PZT module can be seen in Figure 2. For the structural health monitoring of fiber-reinforced structures, ultrasound transducers made of LTCC/PZT modules were produced (Figure 1) within the BMBF project "SHM-MiFaLu". With this impact on airplane structures could be detected and analyzed.



1 Ultrasound transducer for structural health monitoring (cooperation: IZFP, TU Dresden IAVT).

2 LTCC/PZT module cast in aluminum component (false-color X-ray).