As an example, piezoelectric composites processed using dielectrophoresis achieve higher permittivity and piezoelectric constants in the poling direction. The enhancement effect depends on particle shape and orientation. The particle orientation depends on processing parameters such as the amplitude and frequency of the applied electric field and the viscosity of the matrix.

In this presentation new possible electroceramic composites will be discussed. Examples will be presented for oriented composites based on Negative Temperature Coefficient (NTC) materials, Pyroelectric and lead free piezoelectric materials.

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**Design of a piezoelectric rotation actuator**

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In order to facilitate active damping within a linear motion system, a self-sensing piezoelectric rotation actuator has been designed. The rotation actuator consists of two piezoelectric stacks that function as linear actuators, embedded in a mechanical interface with several elastic elements, thus allowing for an efficient transformation of linear deformation into rotational motion. Each stack consists of a d33 ceramic multilayer actuator and a d31 ceramic single layer sensor.

Key issues in the design are:
- the trade-off between strength and stiffness of the elastic elements on the one hand and actuator stroke at the other hand
- appropriate integration of piezoelectric force sensors so as to allow for active damping based on collocated control
- practical mechanical considerations — e.g. gluing, preloading, stroke limitation — so as to ensure correct loading of the piezoelectric actuators

The rotation actuator as such comprises many of the typical design trade-offs as encountered when using piezoelectric elements in a mechatronic application.

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**Starbugs: Piezoelectric robots for exploring the universe**

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Starbugs are miniature piezoelectric 'walking' robots developed to position large numbers of optical fibres within some of the world's largest telescopes. Their simple design incorporates two PZT piezoceramic tubes to form a pair of concentric 'legs' capable of taking individual steps of less than a micron, yet with the capacity to move a payload several millimetres per second. The robots are able to walk in orthogonal x-y directions and also rotate about their centre, providing a flexible platform for positioning many types of payload. The Australian Astronomical Observatory has developed this novel use of piezoelectric actuator to create an entirely parallel positioning system and thus overcome the inherent limitations of existing fibre positioning technology in telescopes, most significantly that reconfiguration times become high for large numbers of fibres. We present an overview of the piezo-driven Starbug project and its potential scientific impact in the astronomical community. We also discuss some of the challenges encountered when designing a system with over one thousand PZT elements, all of which require high voltage drive signals.