

Liquid crystals change their dielectric properties when applying an electrostatic or a magnetostatic field. Taking the advantage of this phenomenon an analogue steering of a RF signal and therewith the realization of a phase shifter is possible. However, the liquid crystals require an integrating medium. As an integration possibility LTCC (Low Temperature Co-fired Ceramic) will be examined. Alternatives such as glass cavities have already been demonstrated successfully.

The project **LIQUIDA** aims at developing a **liquid** crystal phased array antenna used for transmission of satellite signals at 20/30 GHz. The main project steps are:

- **Development of liquid crystals for microwaves.**
- **Integration of liquid crystals into a multilayer ceramic (LTCC).**
- **Development of phase shifters based on this new technology and other technologies (hybrid, SiGe)**
- **Development of an antenna demonstrator.**



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Liquid Crystal Phase Shifter

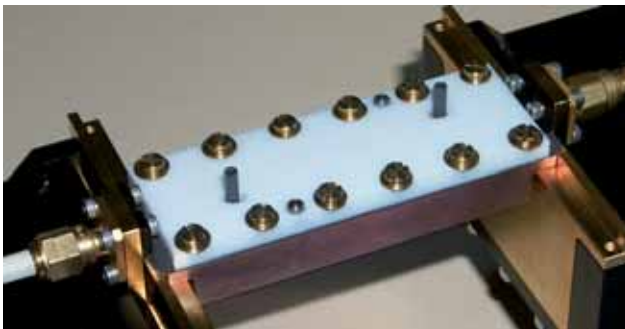
LTCC

Phased Array Antenna



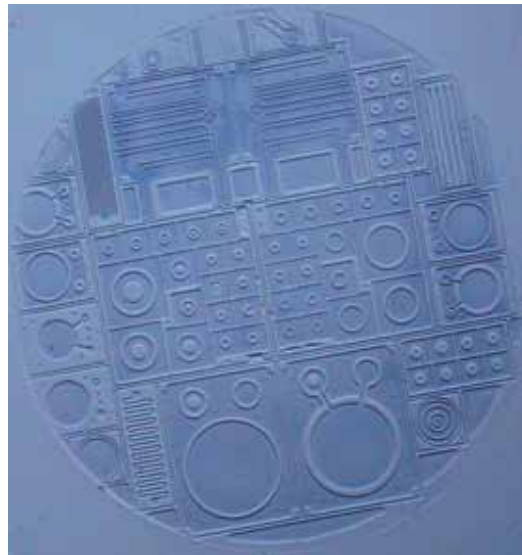
LC-Mixtures consist of 5-25 liquid crystal singles. The function of the LC phase shifter depends on the permittivity of the used media. Since the permittivity of liquid crystals can be changed continuously, the phase shift depends on the dielectric anisotropy of the used

liquid crystal. Such phase shifters based on standard microwave substrates like TMM3 and RT/Duroid have already been demonstrated. The differential phase shift per physical size of the phase shifter will be increased by use of an appropriate microwave design within this project. For this purpose, the description of anisotropic material will be integrated into CAD tools.

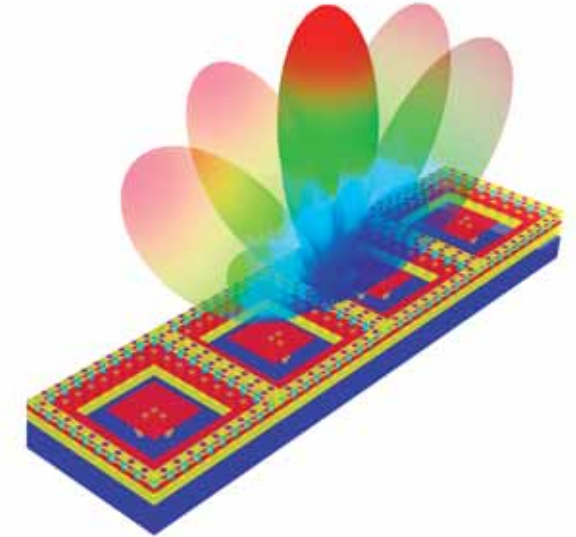


LC-Mixtures and microstrip phase shifter

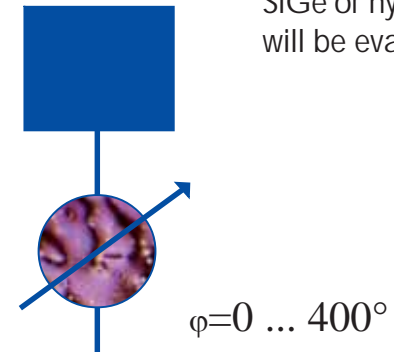
Low Temperature Cofired Ceramic (LTCC) technology represents a suitable ceramic multilayer technology based on glass-ceramic tapes. LTCC offers the means to integrate active and passive components on compact modules in very small areas for different kind of RF applications. LTCC modules are mechanically strong, hermetically sealed, thermally conductive, chemically inert and dimensionally stable. These benefits make LTCC particularly suitable for the integration of Liquid Crystals. The LTCC activities within „LIQUIDA“ will be focused on the creation of dimensionally stable cavities in LTCC multilayers, suitable for the integration of LCs.



Hot embossed structures in LTCC



Based upon a 0...400° phase shifter, a phased array antenna demonstrator will be built. Furthermore, alternative solutions such as SiGe or hybrid LTCC circuits will be evaluated.



Simulation of a phased array antenna