Report on Brite-EuRam Project Sensors and Mechatronic Devices using Ferroelectric Thin Films SEMDEFT

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Abstract. This report describes work carried out over 42 months under a Brite-EuRam project concerned with developing technologies to make use of the piezoelectric and pyroelectric properties of ferroelectric thin films on silicon microstructures, with the aim of addressing the burgeoning need for miniature sensors. To achieve this advances were made in ferroelectric thin film deposition technologies, ferroelectric materials characterisation, silicon micromachining technologies, ferroelectric processing techniques, modelling of ferroelectric devices and fabrication methods for piezoelectric and pyroelectric devices. The outcome of fabricating both piezoelectric and pyroelectric ferroelectric microstructures will be described.

1. INTRODUCTION

Over the last 3 years considerable developments of ferroelectric microstructure technology was made in a collaborative Brite-EuRam programme entitled 'Sensors and Mechatronic Devices using Ferroelectric Thin Films', or SEMDEFT as it was known within the consortium. The programme was concerned with developing technologies to use the piezoelectric and pyroelectric properties of ferroelectric thin films in silicon microstructures, with the aim of addressing the burgeoning need for miniature sensors. To achieve this research institutions and industrial companies were involved in developing base technologies and collaborating on demonstrator device fabrication. Advances were made in: ferroelectric thin film deposition technologies by Saarbrücken University (SA), Thomson CSF (TC) and GEC-Marconi (GM): ferroelectric materials characterisation by Karlshrue (KA) and Saarbrucken Universities: modeling of pyroelectric devices by Karlshrue: modeling of piezoelectric devices by Brüel and Kjær (BK) and Thomson CSF. New processes were developed at GEC-Marconi for integrating ferroelectric thin films onto Stuttgart University (ST) developed, bulk and surface silicon microstructures. All of these developments were used to fabricate the project demonstrators: a triaxial piezoelectric accelerometer, a sensor/actuator, a piezoelectric microphone, based on bulk silicon micromachined structures and a surface micromachined integrated pyroelectric array.

2. FERROELECTRIC MATERIALS

2.1 Ferroelectric oxides (GM,TC)

Thin PZT films for device applications were prepared by the sol gel process. Manufacturable sol gel chemical routes have been developed for depositing highly uniform 1µm PZT thin films on 100mm silicon substrates. No preliminary bake is required and the number of deposition cycles has been reduced from 80 to 10 process cycles. The PZT have properties suitable for pyroelectric and piezoelectric devices having pyroelectric coefficients of $300\mu mCm^{-2}K^{-1}$ and piezoelectric coefficients, d_{31}, greater than 70pC/N. Processes for developing relaxor PMN-PT have been developed although further work is required before these can be incorporated into devices.