Discussion Article

Utilisation of Microsystems Technology in Radio Frequency and Microwave Applications

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Summary. The market trends of the rapidly growing communication systems require new product architectures and services that are only realisable by utilising technologies beyond that of planar integrated circuits. Microsystems technology (MST) is one such technology which can revolutionise radio frequency (RF) and microwave applications. This article discusses the enabling potential of the MST to meet the stringent requirements of modern communications systems. RF MST fabrication technologies and actuation mechanisms empower conventional processes by alleviating the substrate effects on passive devices and provide product designers with high quality versatile microscale components which can facilitate system integration and lead to novel architectures with reduced robustness and reduced power consumption. An insight on the variety of components that can be fabricated using the MST is given, emphasizing their excellent electrical performance and versatility. Research issues that need to be addressed are also discussed. Finally, this article discusses the main approaches for integrating MST devices in RF and microwave applications together with the difficulties that need to be overcome in order to make such devices readily available for volume-production.

Keywords: MST, Micromachining, MEMS, RF Integrated Circuits

Introduction

The rapidly growing communication systems entail demands for a wide range of radio frequency (RF) and microwave transceivers, and as a consequence, the research and development of such systems has dramatically increased in these last years. Amongst the common demands of present day and future RF and microwave applications, one finds the need for lower weight, low power consumption and low cost with increased functionality, frequency of operation and component integration. Consumers also demand for highly personalised, ever-present access to information together with growing volumes of data traffic and the need of higher quality products.

Such market trends require new product architectures that are enabled by technologies beyond that of planar integrated circuits (ICs). Microsystems technology (MST) is one such technology and is on the verge of revolutionising RF and microwave applications (Hilbert & Morris 2002). RF MST provides product designers with high quality versatile three-dimensional (3-D), microscale design components that can be manufactured using traditional IC batch fabrication techniques. These components have the potential for enhancing performance and robustness together with the reduction of power consumption and size of modern wireless architectures (Nguyen 2005).

RF MST components are generally classified into two categories: micro-machined components and micro-electro-mechanical systems (MEMS). The difference between them is that in an RF MEMS component, in addition to the micro-machined RF element, there is an electro-mechanical actuator which is able to convert a voltage or current signal into a

mechanical movement to provide re-configurability to the device. RF MEMS are generally actuated using electro-static, piezoelectric, magnetic or electro-thermal mechanisms. In contrast to European terminology, in the US and Asia, the term MEMS loosely represents micro-systems technology (Lucyszyn 2004).

Very high quality factor (Q) passive devices, such as tunable capacitors with Q values up to 300 at 1 GHz (Young & Boser 1996, Yoon & Nguyen 2000) and inductors with Q values up to 85 at 1 GHz (Van Shaylenbergh et al. 2002), transmission line structures (Dorachmind et al. 2004, Kintis & Berens 1997), mechanical resonators (Wang et al. 2004a, 2004b) and switches with insertion loss as low as 0.1 dB (Yao et al. 1999) are achievable using MST. Such devices can be implemented as discrete components or, for highly-integrated portable applications, merged with ICs through post-processing manufacturing techniques. MST components have been a very interesting area for research and development showing their excellent performance at microwave and even at mm-wave frequencies (Milosavljevic 2004). Such excellent performance comes from the possibility of the MST to limit the substrate coupling effects and the availability of metal structures with low parasitic capacitance and contact resistance.

RF MST structures are already being developed for switching applications such as transmit/receive duplexers (TDD) and band-mode selection which is fundamental for modern wireless multi-mode multi-standard applications. Also micromachined film bulk acoustic resonators (Otis & Rabaey 2003) are already carried in many mobile handset platforms for two-way voice and data traffic (Coventor Inc. 2005). New applications are emerging in

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Books in Print ,1998   **Emerging Multimedia Computer Communication Technologies** Chwan-Hwa Wu,J. David Irwin,1998 The most complete reference covering every type of emerging technology in multimedia computer communications   **Proceedings of the … International Symposium on Microelectronics** ,2000   **Etching in Microsystem Technology** Michael Köhler,2008-07-11 Microcomponents and microdevices are increasingly finding application in everyday life The specific functions of all modern microdevices depend strongly on the selection and combination of the materials used in their construction i e the chemical and physical solid state properties of these materials and their treatment The precise patterning of various materials which is normally performed by lithographic etching processes is a prerequisite for the fabrication of microdevices The microtechnical etching of functional patterns is a multidisciplinary area the basis for the etching processes coming from chemistry physics and engineering The book is divided into two sections the wet and dry etching processes are presented in the first general section which provides the scientific fundamentals while a catalog of etching bath composition etching instructions and parameters can be found in the second section This section will enhance the comprehension of the general section and also give an overview of data that are essential in practice   **1995 International Symposium on Microelectronics** ,1995   **QoS Guarantees in Wireless/mobile Networks** Sunghyun Choi,1999   *1995 International Symposium on Microelectronics* International Symposium on Microelectronics (28, 1995, Los Angeles, Calif.),1995   **Silicon Carbide Microsystems for Harsh Environments** Muthu Wijesundara,Robert Azevedo,2011-05-17 Silicon Carbide Microsystems for Harsh Environments reviews state of the art Silicon Carbide SiC technologies that when combined create microsystems capable of surviving in harsh environments technological readiness of the system components key issues when integrating these components into systems and other hurdles in harsh environment operation The authors use the SiC technology platform suite the model platform for developing harsh environment microsystems and then detail the current status of the specific individual technologies electronics MEMS packaging Additionally methods towards system level integration of components and key challenges are evaluated and discussed based on the current state of SiC materials processing and device technology Issues such as temperature mismatch process compatibility and temperature stability of individual components and how these issues manifest when building the system receive thorough investigation The material covered not only reviews the state of the art MEMS devices provides a framework for the joining of electronics and MEMS along with packaging into usable harsh environment ready sensor modules   *Circuits and Systems in the Information Age* Yih-Fang Huang,1997   **The Software Encyclopedia** ,1988   *The Cumulative Book Index* ,1996 A world list of books in the English language   **American Book Publishing Record** ,2004   **Subject Guide to Books in Print** ,1996

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