Introduction

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After its emergence in the late eighties, MEMS (Micro-Electro-Mechanical-Systems) or MST (Microsystems Technology) has developed into billion $ commercial markets, in particular in the automotive, medical, and telecommunication fields. The Lecture Series will address applications in the aerospace field, which encounter unique challenges related to harsh environment conditions and reliability requirements. This Introduction will provide a brief introduction into the MEMS technology, discuss examples of commercial and potential aerospace applications, and introduce the lectures, which will focus on six specific aerospace applications.

MEMS are miniature devices, which integrate actuators, sensors, and processors to form intelligent systems. Functional sub-systems could be electronic, optical, mechanical, thermal or fluidic. MEMS are characterized by their close relationship to integrated-circuit components both in terms of manufacturing techniques and their potential for integration with electronics. One example of a true MEMS system, which will be discussed, is the “Smart Micro Skin” which combines sensors, actuators, and controller to detect and control flow separation at the leading edge of a delta wing.

Several manufacturing techniques are required to develop MEMS, including surface micromachining. In this process mechanical microstructures are fabricated on the surface of a wafer by depositing different types of layers. Deposited layers include structural layers, which form the final structures, and sacrificial layers, which are removed in the final stage of the fabrication through the edging process.

The advantages of MEMS are numerous. They include miniaturization (allowing distributed sensing and actuation coupled with redundancy), reduced cost of fabrication (through the use of microelectronics processing technologies), and real-time control (allowing on-line active process control and health monitoring). In addition, micro devices can control macro systems by using natural physical amplification characteristics of the system. For example, the control of flow separation at the leading edge of delta wings by micro actuators allows the control of the leading-edge-vortex position, which determines lift and moments.

Examples for MEMS commercial applications, which will be discussed, include digital micro mirrors for projectors and micro total analytical systems.

Many MEMS aerospace and military applications are being considered. Examples are micro jet arrays for flow control, IMUs (Inertial Measurement Units) for inertial measurement and navigation, fuze/safety and

Paper presented at the RTO AVT Lecture Series on “MEMS Aerospace Applications”, held in Montreal, Canada, 3-4 October 2002; Ankara, Turkey, 24-25 February 2003; Brussels, Belgium, 27-28 February 2003; Monterey, CA, USA, 3-4 March 2003, and published in RTO-EN-AVT-105.

arming for munitions, health monitoring of machinery, and telecommunication for pico satellites. The MEMS aerospace applications are confronted with barriers and challenges, which are more severe than for commercial applications. This resulted in slow progress of inserting many of the potential MEMS aerospace applications.

Military MEMS applications are being addressed in the NATO RTO (Research and Technology Organization) MEMS Task Group AVT (Applied Vehicle Technology) –078. This Group is assessing potential applications, determining technology status and R&D needs, discussing barriers for implementation, and developing insertions strategies. The Task Group saw the need to enhance user and MEMS supplier interactions and to increase MEMS awareness as enabling technology for several applications. Because of this need, the Task Group has proposed these Lecture Series, which will provide an introduction into MEMS technology and then focus on six potential applications, namely micro-flow control, IMU, fuze/safety & arming, micro power, gas turbines applications, inventory and health monitoring of munitions. Also an introduction into MOEMS (Micro-Optical-Electro-Mechanical-Systems) will be provided.