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SILICON-MICROMACHINED THZ SYSTEMS - ENABLING THE LARGE-SCALE EXPLOITATION OF MILLIMETER AND SUBMILLIMETER-WAVE FREQUENCIES?

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Abstract:

Current THz systems are predominantly manufactured by CNC milling. Despite the high level of precision which CNC milling achieved in recent years, this fabrication method lacks volume manufacturability and is inferior in performance to silicon micromachining, which achieves feature sizes and fabrication reproducibility down to micrometers, surface roughness down to nanometers (for extremely low loss), and high-aspect ratio geometries which are impossible to fabricate in any other fabrication technology. Micromachined micromechanical devices, for instance mobile-phone microphones and inertial sensors, are already for many years manufactured to billions of devices per year at very low cost. This webinar gives an overview of state of the art, the capabilities and limitations of silicon micromachining for millimeter and submillimeter-wave frequencies, and gives several examples of recent achievements of very high performance silicon-micromachined waveguide based THz devices and systems, including: a low-loss waveguide technology with 0.02 dB/mm at 330 GHz, with integrated components such as low-loss couplers, power splitters, matched loads; micromachined high-Q filter examples based on cavity resonators with measured Q-factors of 1600 at 150 GHz and 900 at 700 GHz, enabling the first 1% fractional bandwidth filters at submillimeter-wave frequencies; a silicon-micromachined platform for a point-to-point telecommunication link including a 130-148 GHz antenna diplexer with 1.5 dB insertion loss and 60 dB isolation, and waveguide-integrated SiGe MMICs; very complex, multi-level waveguide devices including a orthomode transducer from 220-330 GHz with less than 0.6 dB insertion loss and cross-polarization of 35-70 dB in this waveguide band; a corporate-fed antenna array with 256 elements at 320 to 400 GHz, with only 0.8 dB insertion loss, achieving 34 dBi gain; a 1024 antenna array at 320-400 GHz with 38 dBi gain and 1.5 dB insertion loss; a frequency-steering micromachined radar frontend at 220-300 GHz, achieving a 55 degree field of view with a 3.5 to 10 degree HPBW, using an integrated 2.5D quasi-optical reflector and a leaky-wave antenna array, all of the size and thickness of a thumb nail; MEMS-waveguide switches operating at 140-220 GHz with 0.6 dB insertion loss and 50 dB isolation over the

whole band, and even a 500-750 GHz switch with 2.5 dB insertion loss and 18 dB isolation; and a 2.5-dB insertion loss 360 degree phase shifter for the 220-330 GHz band with less than 4 degree phase error for all states over the whole bandwidth. Major applications presented are radar (in particular next-generation car radars), telecommunication and space-borne radiometers.

CV:

Joachim Oberhammer, born in Italy in 1976; M.Sc. EE from Graz University of Technology, Austria, in 2000; Ph.D. from KTH Royal Institute of Technology in Stockholm, Sweden, in 2004. Post-doctoral research fellow at Nanyang Technological University, Singapore, in 2004, and at Kyoto University, Japan, in 2008. Since 2005 leading radio-frequency/microwave/terahertz micro-electromechanical systems research at KTH; Associate Professor at KTH in 2010; Professor in Microwave and THz Microsystems at KTH since 2015. Guest researcher at Nanyang Technological University, Singapore, in 2007; guest researcher at NASA-Jet Propulsion Laboratory, USA, in 2014; guest professor “Chair of Excellence” at Universidad Carlos III de Madrid in 2019. Dr Oberhammer is author and co-author of more than 100 reviewed research papers and holds 4 patents. In 2004, 2007, and 2008 he got an award by the Ericsson Research Foundation, a grant by the Swedish Innovation Bridge, and a scholarship by the Japanese Society for the Promotion of Science, respectively. The research work he is heading received six Best Paper Awards (five of which at IEEE conferences), and four IEEE Graduate Fellowship Awards (by MTT-S and by AP-S) since 2009. He served as TPRC member of IEEE Transducers (2009, 2015, 2019), IEEE International Microwave Symposiums (2010-2018), IEEE Micro Electro Mechanical Systems (2011, 2012), IEEE Radio and Wireless Week (2015, 2016), EuMCE (2019). Dr Oberhammer is Steering Group member of the IEEE MTT-S and AP-S Chapters Sweden since 2009. In 2013, he received an ERC Consolidator Grant by the European Research Council. Steering Group Member of the Young Academy of Sweden 2014-2016. Representative of Sweden/Norway/Iceland in the European Microwave Association 2016-2018. Associate Editor of IEEE Transactions on Terahertz Science and Technology since 2018. Scientific coordinator of the EU-H2020 projects M3TERA and Car2TERA; PI and coordinator of two Swedish strategical framework projects on THz technology of EUR 3.5 million each.

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