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Miniature diffraction-based optical MEMS microphones with integrated optoelectronics

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Diffraction-based optical interferometric sensing has been shown to be a low-noise displacement detection method for MEMS microphones. For this method to be useful in many important applications such as hearing aids, it needs to be packaged in a small volume and should have power consumption levels suitable for operation with a battery. In this talk, we describe miniature, packaged optical microphones that use solid state vertical cavity surface emitting lasers (VCSELs) as light sources and custom designed photodetectors. The package carries silicon chips with two micromachined biomimetic differential microphones as well as an omnidirectional microphone. It is made by 3-D laser stereo lithography process and has dimensions suitable for behind-the-ear hearing aids. With this configuration, the input referred noise floor for the differential microphone is measured as 42.6dBA, limited by the VCSEL intensity noise in this particular case. In addition to miniature packaging, an optoelectronic chip including VCSEL pulser, photodetectors, transimpedance amplifiers and 1 bit Sigma-Delta ADC has been implemented in 1.5V, 0.35u CMOS technology. The second order ADC structure providing 14-bits of theoretical resolution with 64 over sampling ratio and 20 kHz input signal is described and initial characterization results are presented.