Directional Microphone Array Fabrication

CNF Project # I116-03
Principal Investigator: Ronald N. Miles

Abstract:

The goal of this project is to fabricate prototypes of novel silicon microphone arrays. The microphone arrays consist of two differential microphones and one omni-directional microphone on each die. The miniature directional microphone technology is being developed for applications in hearing aids.

Introduction:

Several new microphone designs and fabrication processes were developed and refined this past year. These designs included microphones that utilize conventional capacitive sensing as well as microphones that incorporate optical gratings to allow an optical detection of the diaphragm displacement. The capacitive microphones are composed of polysilicon diaphragms and polysilicon backplates separated by a small gap to permit capacitive sensing. The essential fabrication steps include deep reactive ion etch, sacrificial oxide growth, doped polysilicon deposition, chemical mechanical polishing, phosphorus-containing silica glass deposition, backplate polysilicon deposition, backside cavity etch, and final structure release with buffered HF etch.

The effect of the angle of incidence of the sound on the response of our differential silicon microphones has been measured and shown to be in excellent agreement with theoretical predictions.

Other activities included polysilicon chemical mechanical polishing; development of dry-release technology; development of a backside RIE recipe; experiments on fabrication of sputtered RIE backplates and gold plated backplates; fabrication of gold backplates using electro-plating technology; and fabrication of conventional capacitive microphones with gold backplates.

Some of the challenges encountered at CNF included the re-characterization of the doped polysilicon furnace, some tool difficulties and equipment down time.

Summary:

Several polysilicon microphone designs have been successfully designed, refined, produced and tested. Acoustic testing of these parts shows a very satisfactory yield and performance. The next step in this project is the refinement of the MEMS prototype microphone circuits and package, which is currently underway. The package will be used to demonstrate the performance and limitations of the MEMS directional microphones and circuitry and allow the team to address issues prior to circuit miniaturization.

References:


Directional Microphone Array Fabrication

CNF Project # 1116-03
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• Goal: Fabricate prototypes of novel silicon microphone arrays.
• The capacitive microphones consist of polysilicon diaphragms and polysilicon backplates.
• Microphone arrays included two differential and one omni-directional microphone as shown in Figure 1.
• The acoustic directivity pattern of the differential microphones corresponds to the “ideal” figure-eight pattern as shown in Figure 2.
• Primary application: hearing aids.

Figure 1: Chip containing an array of two differential and one omni-directional microphone. The chip dimensions are 4.5 x 5.5 mm.

Figure 2: Polar plot showing the response of our differential microphone as a function of the angle of incidence of the sound.