

A High Performance MEMS Thin-Film Teflon Electret Microphone

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Report Documentation Page

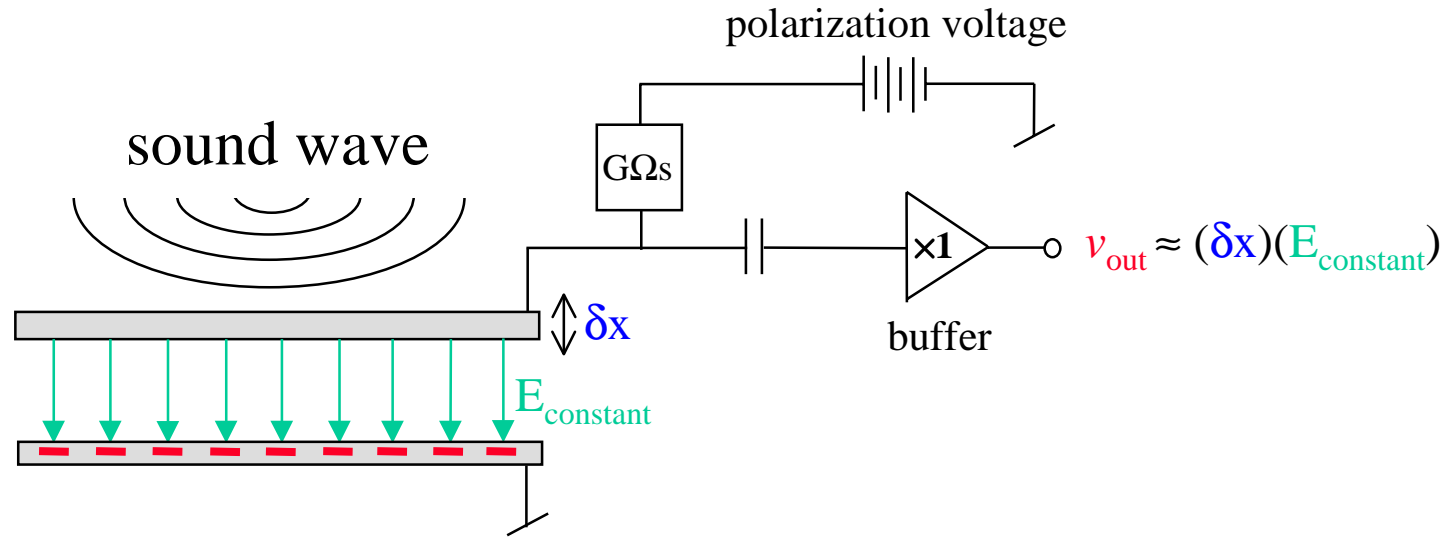
*Form Approved
OMB No. 0704-0188*

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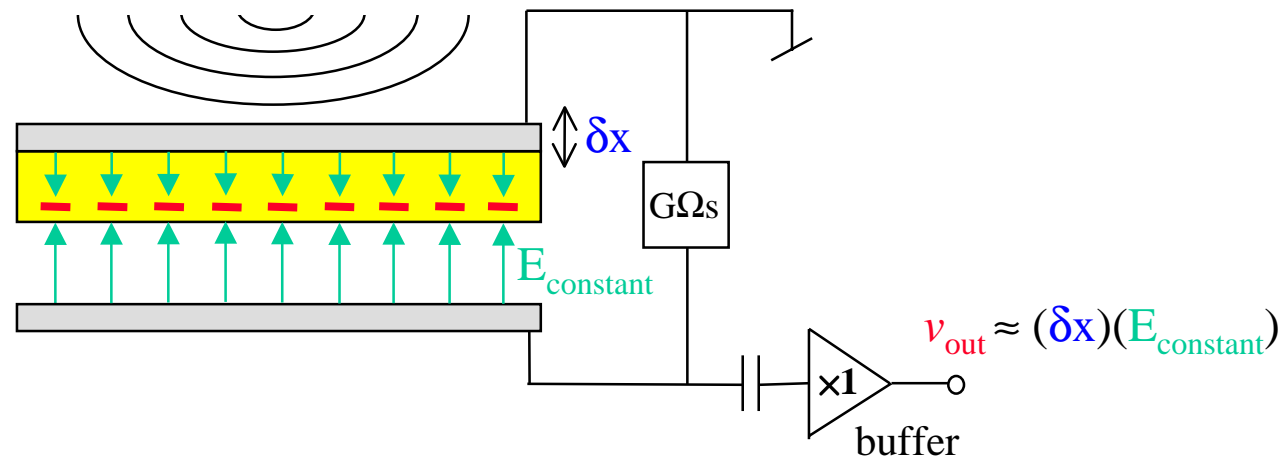
1. REPORT DATE 24 AUG 1999	2. REPORT TYPE N/A	3. DATES COVERED -	
4. TITLE AND SUBTITLE High Performance MEMS Thin-Film Teflon Electret Microphone		5a. CONTRACT NUMBER	
		5b. GRANT NUMBER	
		5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)		5d. PROJECT NUMBER	
		5e. TASK NUMBER	
		5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) California Institute of Technology		8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)	
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release, distribution unlimited			
13. SUPPLEMENTARY NOTES DARPA, Air-Coupled Acoustic Microsensors Workshop held on August 24 and 25, 1999 in Crystal City, VA., The original document contains color images.			
14. ABSTRACT			
15. SUBJECT TERMS			
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified	UU
			18. NUMBER OF PAGES 12
			19a. NAME OF RESPONSIBLE PERSON

Condenser Microphones: Principal of Operation

Externally
Biased

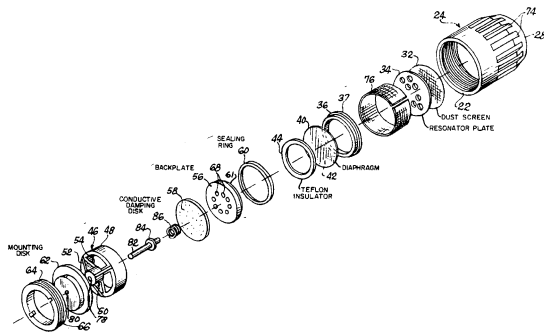


Self-Biasing
(electret)

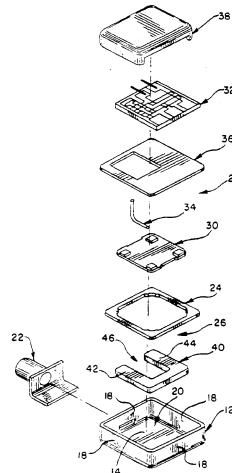


Micromachined Electret Condensator Microphones

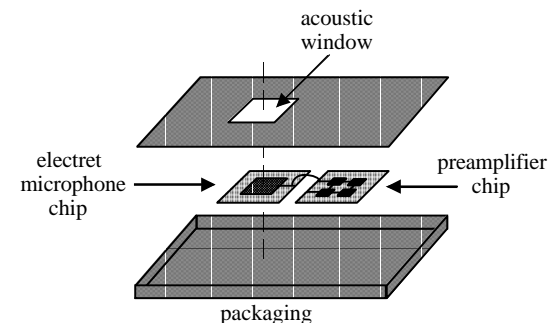
- Requires no external power source (**self-biasing**)
- Can be **mm-scale** with **high sensitivity** (10+ mV/Pa)
- **Integrable** with **on-chip electronics**
- **Mass producible** like ICs → low cost, high yield
- **Structurally simple** → increased reliability



Electro-Voice®



Knowles®

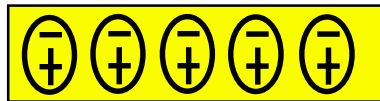
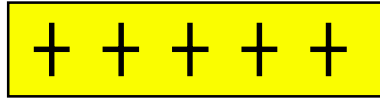
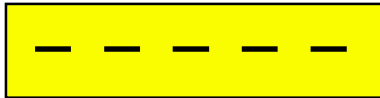


Our Envisioned
Micromachined Microphone



What is an Electret?

dielectric with trapped charge



$\tau_{\text{decay}} =$
10's - 100's yrs

History

1732	<i>Electret phenomena (Gray)</i>	[slabs]
1919	<i>Wax electrets (Eguchi)</i>	[mm]
1950+	<i>PTFE, PVDF, Mylar sheet</i>	[>10 μm]
1962	<i>1st electret mic. by Sessler</i>	[6 μm]
1997	<i>Thin film Teflon electret</i>	[1 μm]

Applications

μ - microphone/speaker

μ - air filters

μ - motors & generators

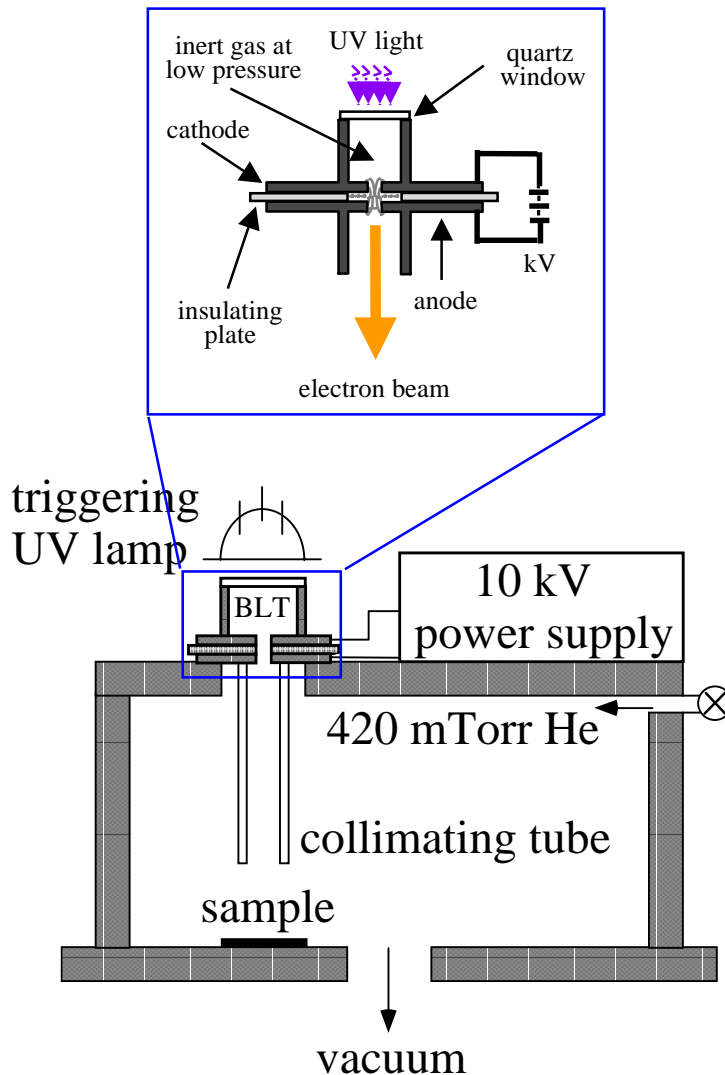


Thin Film Teflon[®] Electret Technology

<i>Material</i>	DuPont Teflon [®] AF
<i>Application</i>	Spin on, bake @ 200°C
<i>Charge Implantation</i>	Back-Lighted Thyratron pulsed electron gun (keV e^- s)
<i>Charge Stabilization</i>	Thermal annealing
<i>Charge Measurement</i>	Charge compensation method
<i>Achievable Stable Charge Densities</i>	$1 \times 10^{-5} \text{ C/m}^2$ to $8 \times 10^{-4} \text{ C/m}^2$



Charge Implantation using the BLT



Advantages

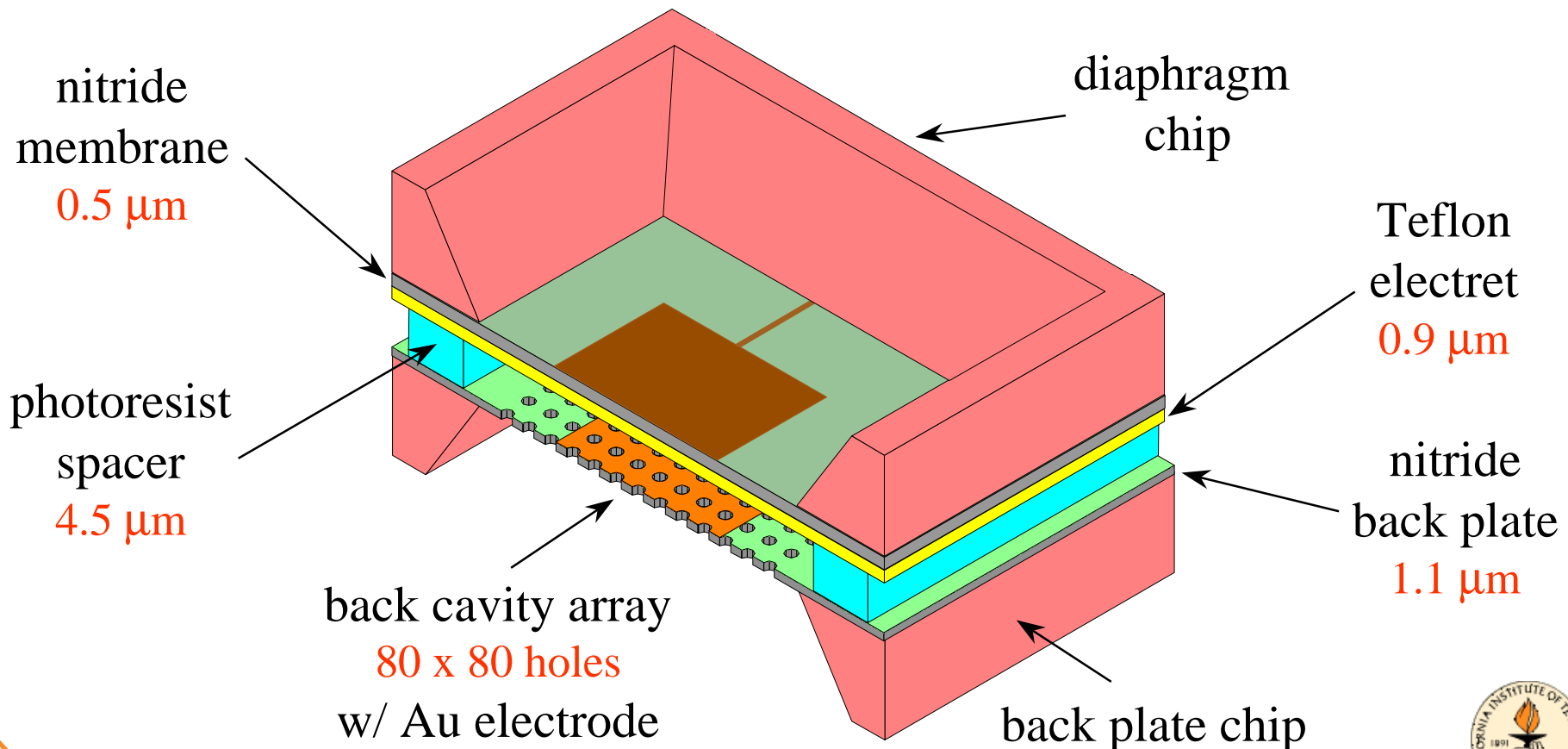
- Room temperature
- Large beam size (>mm)
- Variable energy (5 keV - 30 keV)
- High electron dose (10^{-9} - 10^{-6} C)
- High throughput
- Low Cost

MEMS Electret Microphone

Sensitivity: ~ 45 mV/Pa

Dynamic Range: less than 30 - 110+ dB SPL

THD: <1% @ 110 dB SPL, 650Hz



Microphone Diaphragm & Back Plate

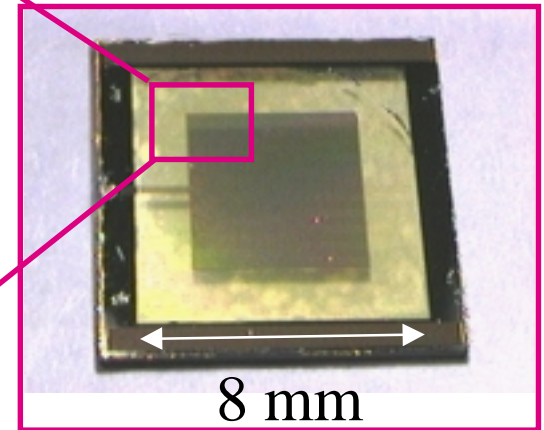
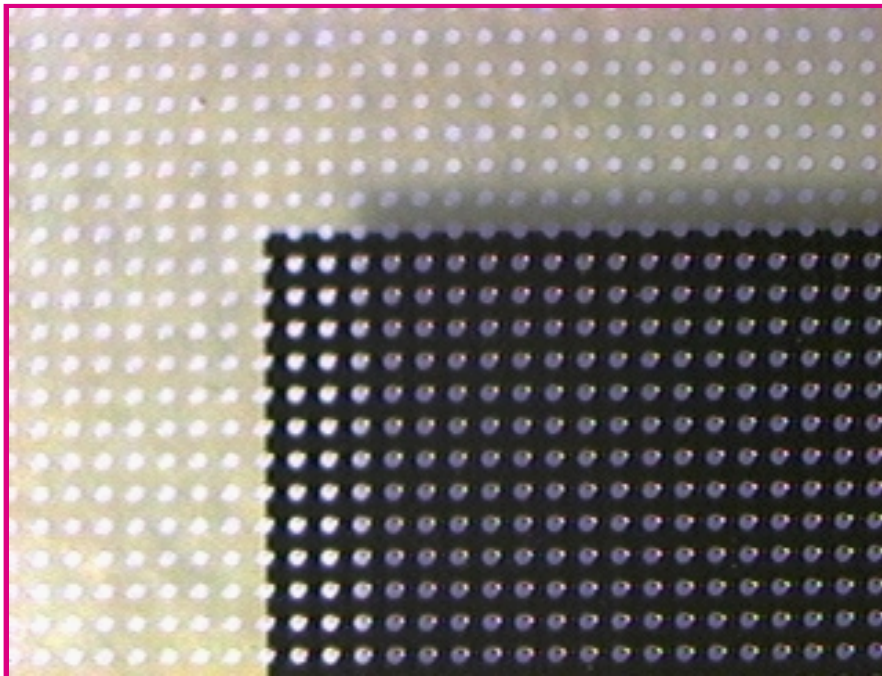
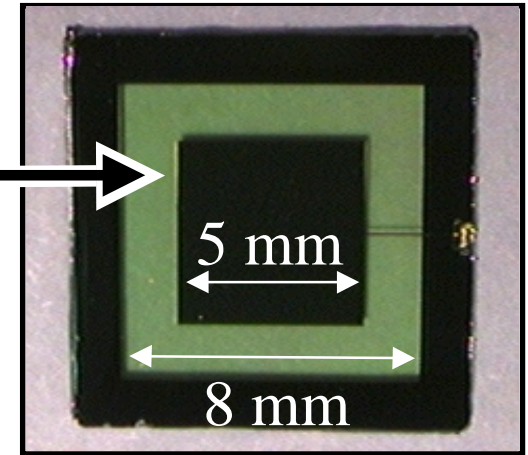
Nitride membrane die



Cr/Au electrode



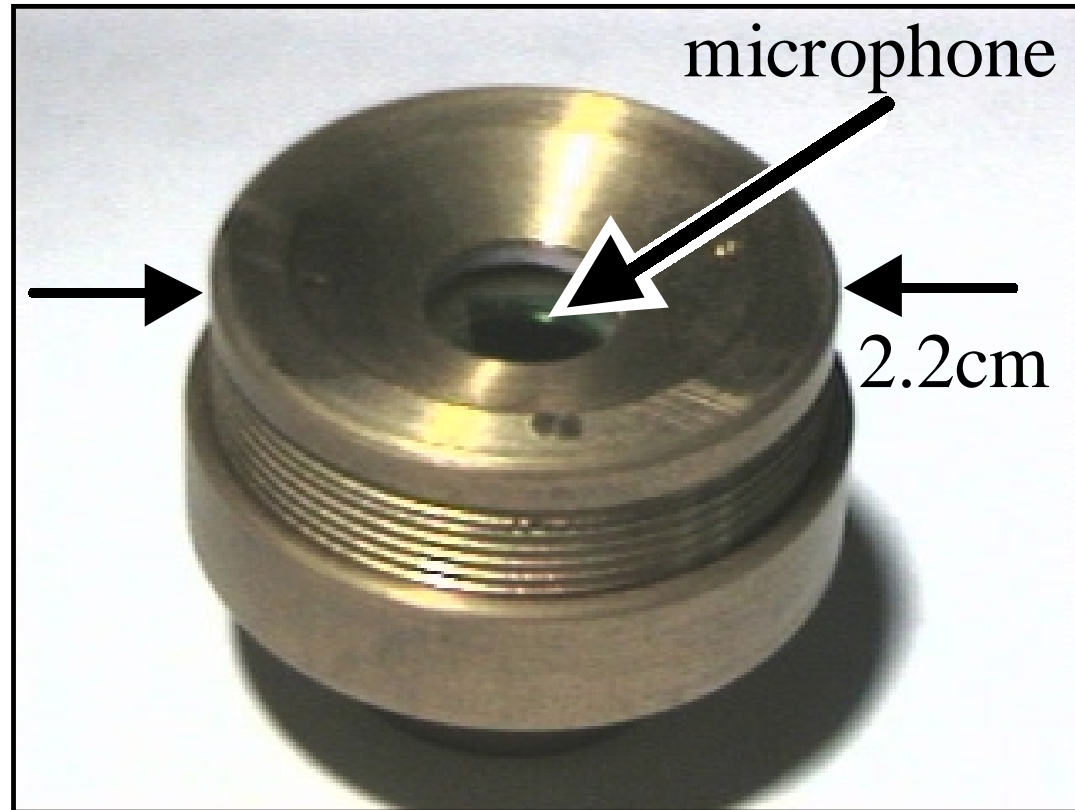
160 x 160 back cavity array



Microphone Back Plate Process Flow



Electret Microphone Package



Microphone Characteristics

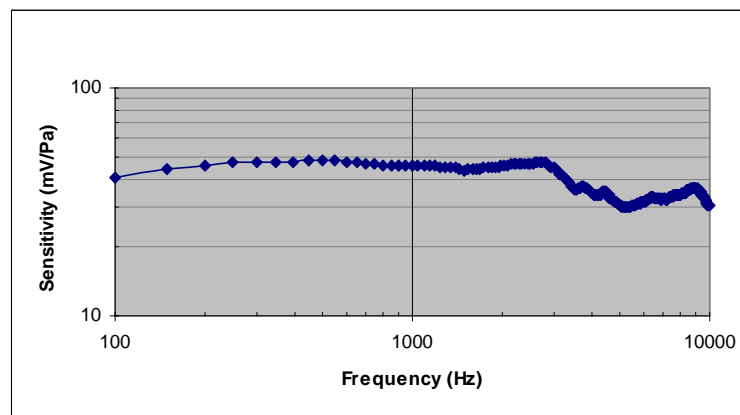
Bias Voltage: 0 V

Open-circuit Sensitivity: ~ 45 mV/Pa (150-3000 Hz)
(comparable to B&K 1/2" 4189 electret microphone!)

Frequency Range: 100 Hz - 10 kHz

Dynamic Range: less than 30 - over 110 dB SPL

THD: <1% @ 110 dB SPL, 650Hz



Frequency Response



Microphone Array for Directional Acoustics

