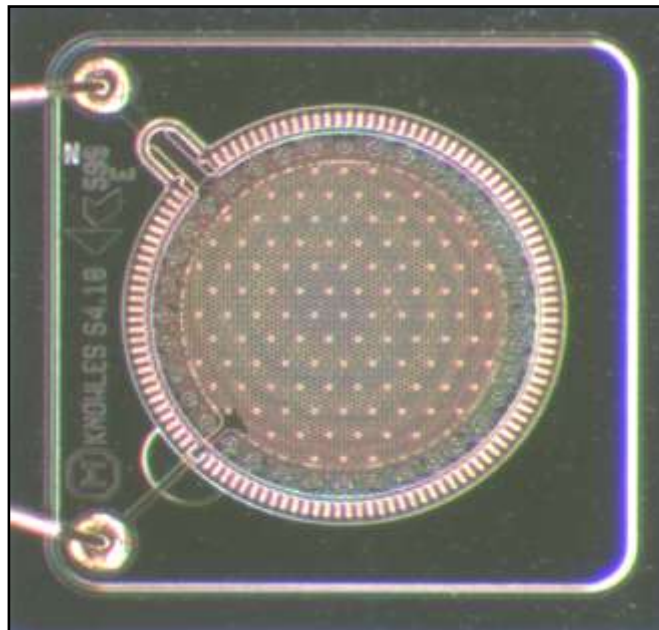


Reverse Costing analysis



Knowles SPM0408HE5H MEMS Microphone

September 2009 - Version 1

Written by: Romain FRAUX

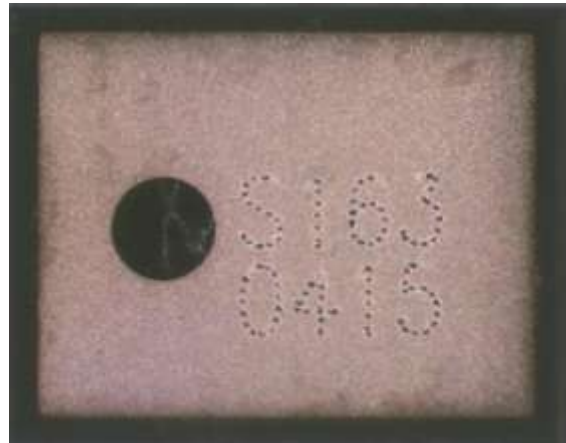
DISCLAIMER : System Plus Consulting provides cost studies based on its knowledge of the manufacturing and selling prices of electronic components and systems. The given values are realistic estimates which do not bind System Plus Consulting nor the manufacturers quoted in the report. System Plus Consulting is in no case responsible for the consequences related to the use which is made of the contents of this report. The quoted trademarks are property of their owners.

Glossary

1. Overview / Introduction.....	4	5. Cost Analysis.....	50
– Executive Summary		– Synthesis of the Cost Analysis	
– Reverse Costing Methodology		– Main Steps of Economic Analysis	
2. Knowles Company Profile	8	– Supply Chain Analysis	
3. Physical Analysis.....	12	– Yields Explanation	
– Synthesis of the Physical Analysis		– ASIC Wafer Cost Hypothesis	
– Physical Analysis Methodology		– Asic Wafer Cost	
– Package Characteristics & Markings		– ASIC Probe & Dicing cost	
– Package X-Ray		– ASIC Die Cost	
– Package Top Cover		– Microphone Wafer Cost Hypothesis	
– Package Composition		– Microphone Wafer Cost	
– Package Opening & Bonding Number		– Microphone Wafer : Equipment Cost per Family	
– ASIC Markings		– Microphone Wafer : Material Cost per Family	
– ASIC Dimensions		– Microphone Probe Cost	
– ASIC Minimal Dimension and Metal Layers		– Microphone Dicing Cost	
– ASIC Transistor Details		– Microphone Die cost	
– ASIC Process Characteristics		– SPM0408 Packaging Cost Hypothesis	
– Microphone Markings		– SPM0408 Packaging Process Flow	
– Microphone Details		– SPM0408 Packaging Cost Details	
– Microphone Dimensions		– SPM0408 Final Test Cost	
– Microphone Structure		– SPM0408 Component Manufacturing Cost	
– Microphone Cross-Section		– Yield Synthesis	
– Microphone process characteristics		– SPM0408 Cost Analysis Evolution	
4. Manufacturing Process Flow.....	45	6. Estimated Manufacturer Price Analysis	75
– Overview		– Manufacturers financial ratios	
– ASIC Process Flow		– Estimated manufacturer Price	
– Microphone Process Flow			
– Description of the Wafer Fabrication Units			

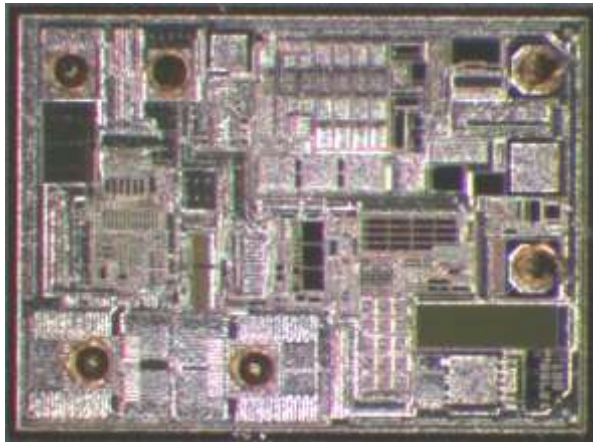
Conclusion

SPM0408HE5H



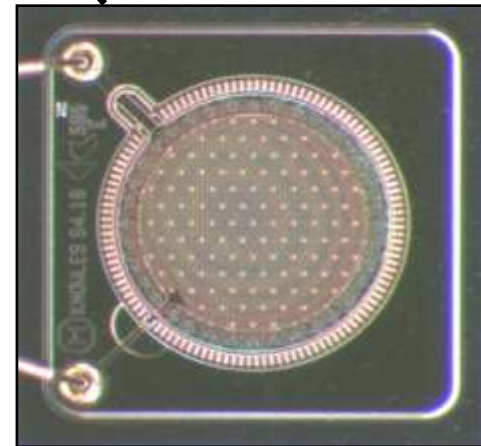
**Assembly in package
Encapsulation
Final test**

ASIC

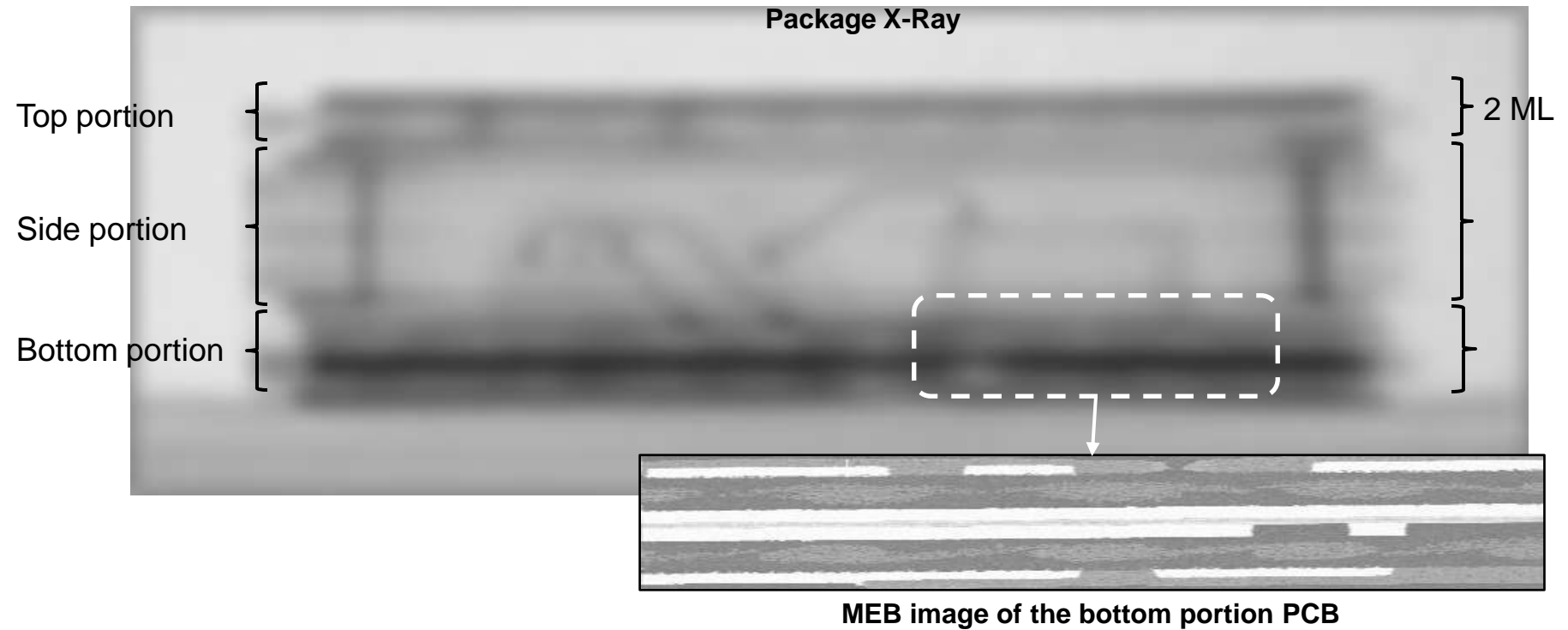


BiCMOS process

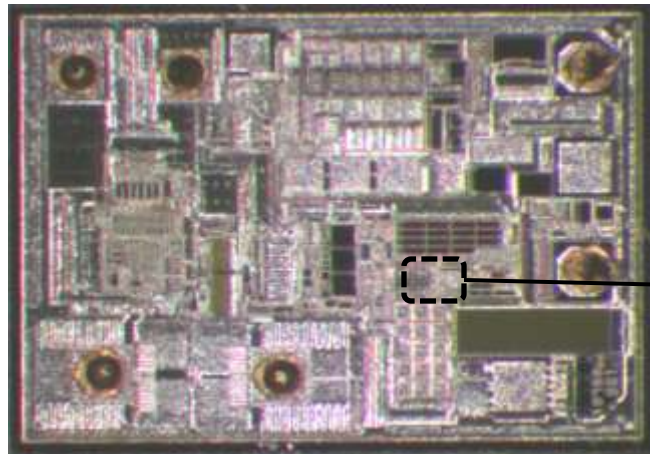
Microphone



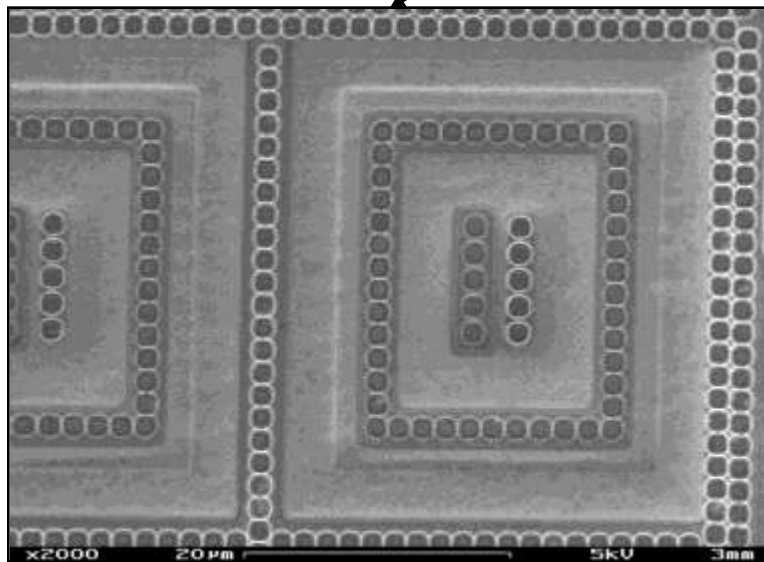
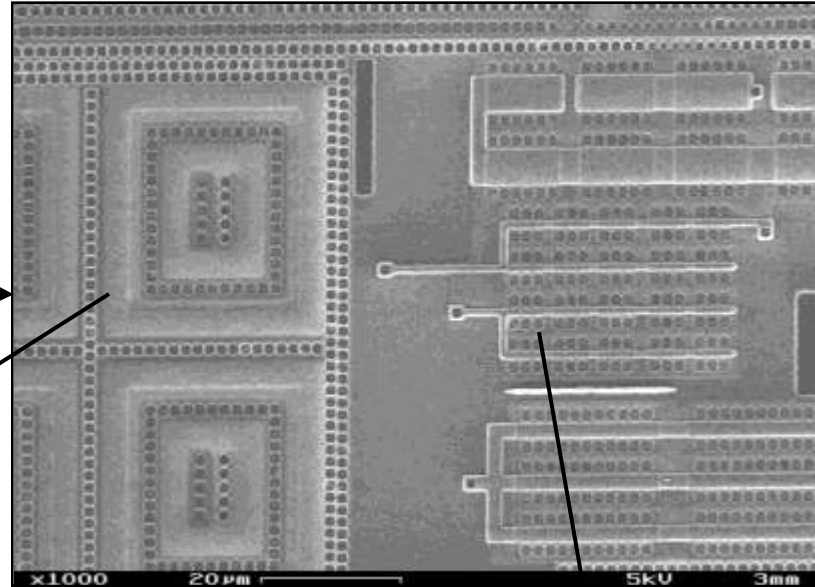
Surface & Bulk micromachining



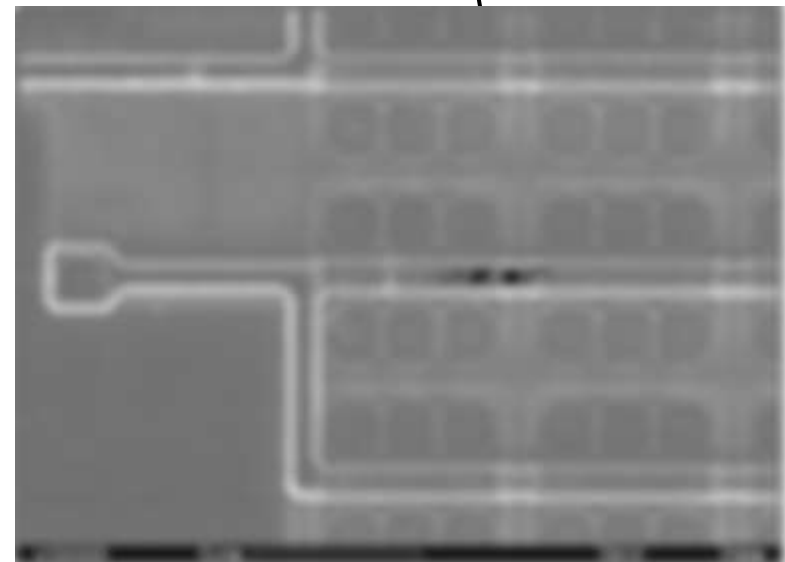
The package is composed of ...



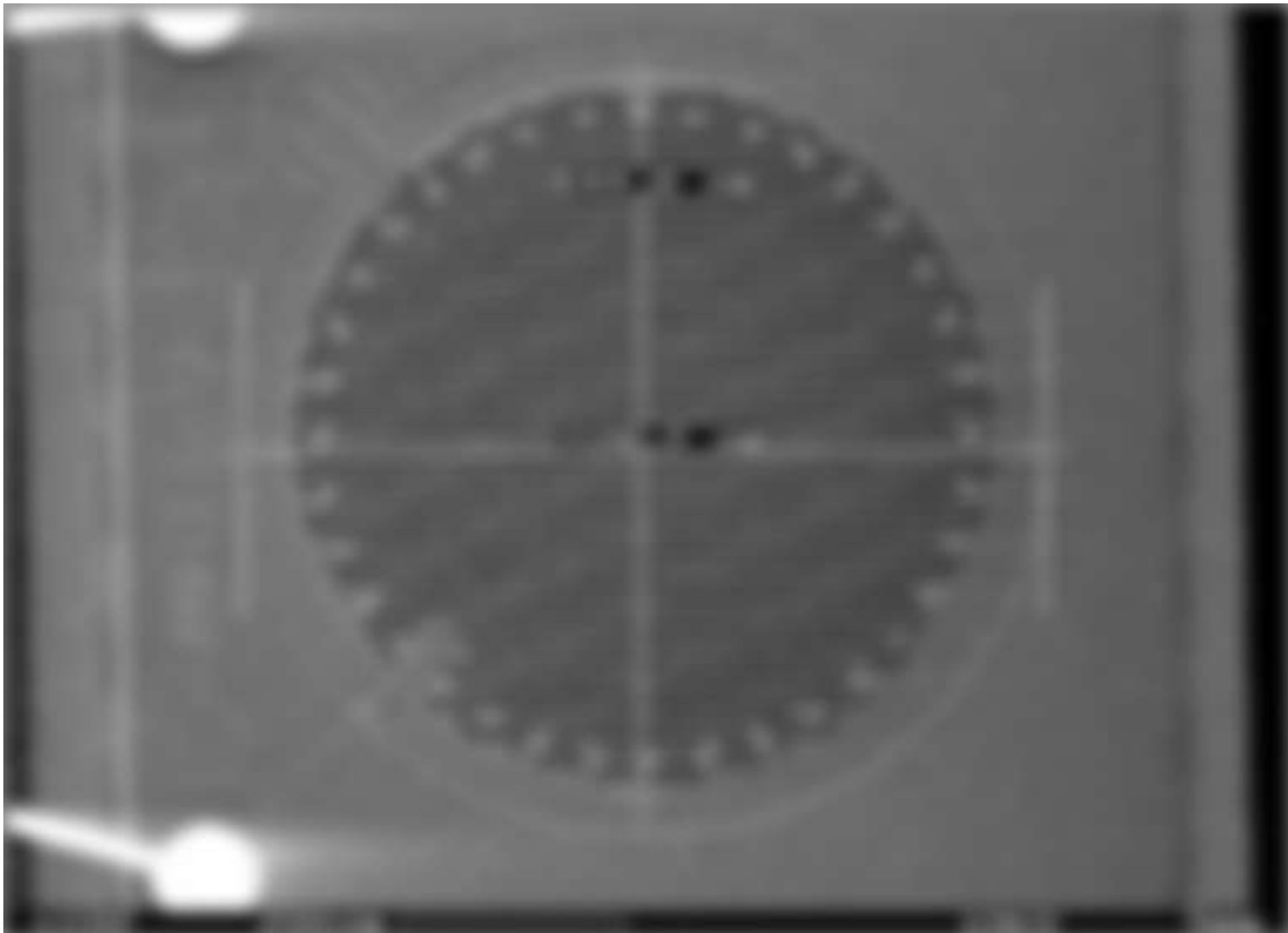
ASIC die

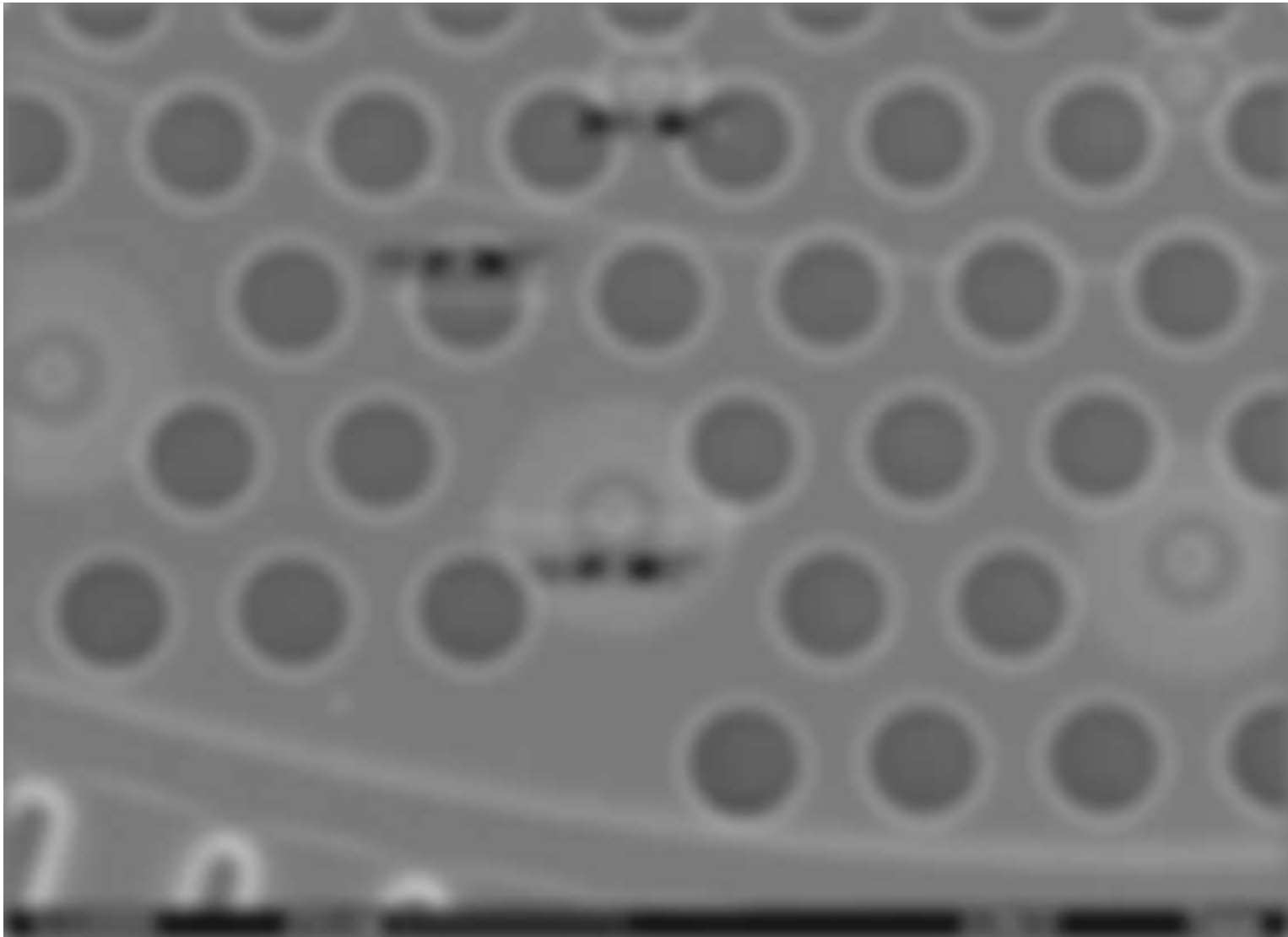


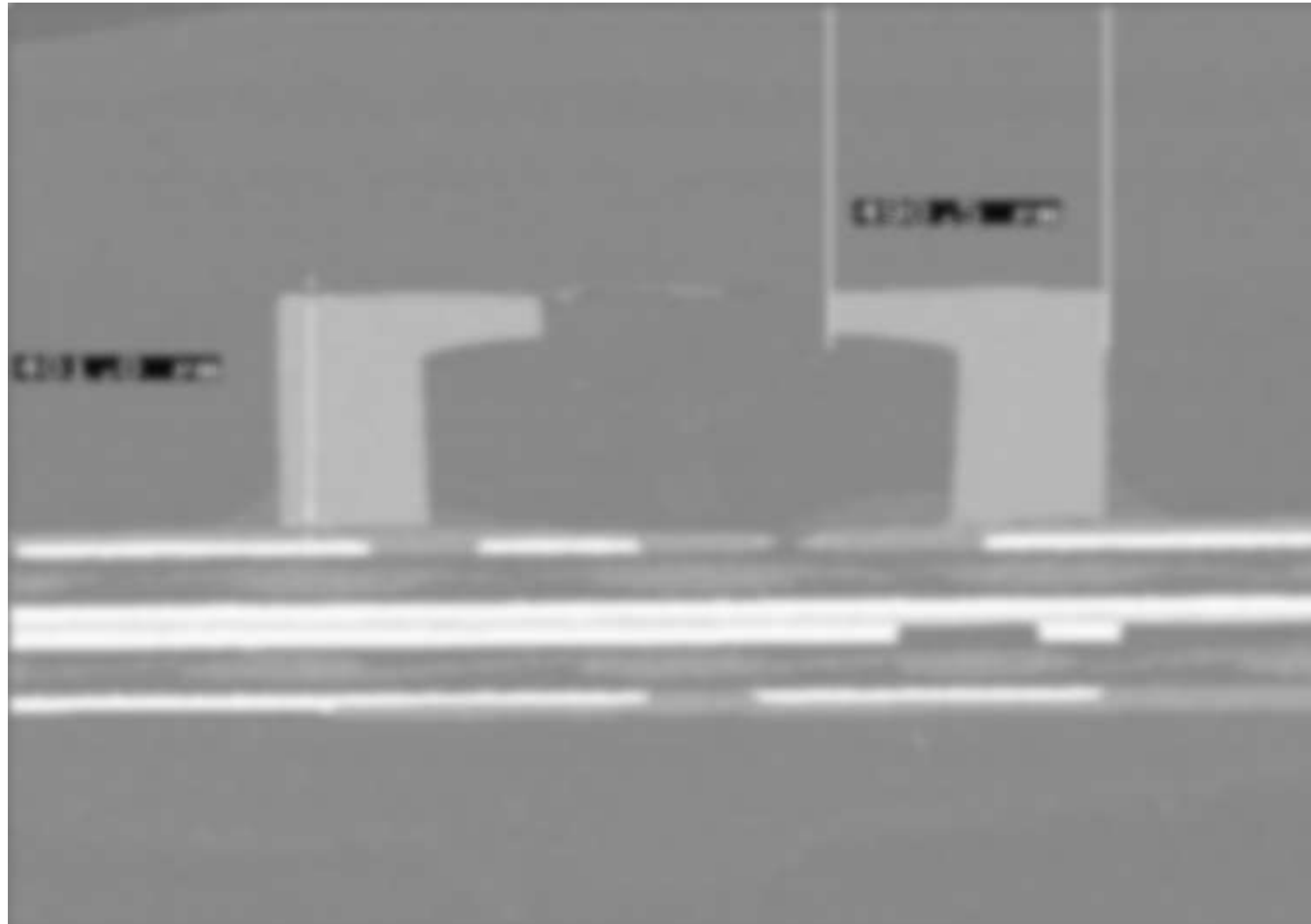
Bipolar transistors



CMOS transistors







• The microphone wafer is manufactured in a xxxmm foundry in xxx:

- Process type: MEMS Surface & Bulk Micro-machining
- Metal layers: x Al (for the pad)
- Polysilicon layer: x
- Lithography steps: xx

- The microphones are manufactured on a standard xxx mm wafer.
- The two polysilicon layers are used for the capacitor plates.
- The wafer thickness xxx μ m is obtained after a backgrinding process.

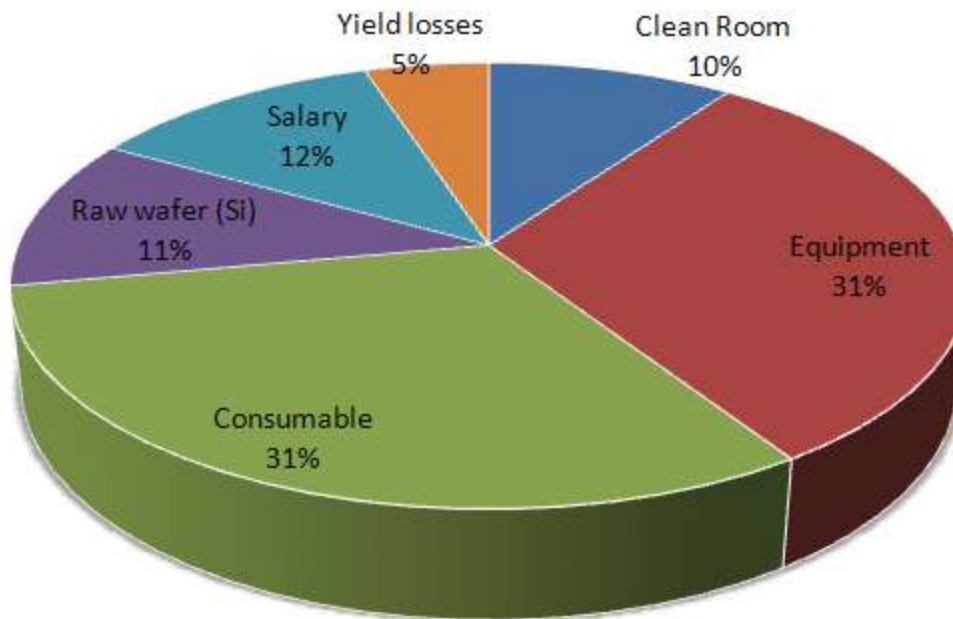


- The SPM0408 component is designed by Knowles Electronics.
- The production of the ASIC by xxx is assumed to take place in the xxx .
 - The ASIC wafer cost is estimated at \$xxx, the die cost is estimated at \$xxx
- The production of the microphone by a MEMS foundry is assumed to take place in a xxxmm wafer foundry in
 - The microphone wafer cost is estimated at \$xxx, the die cost is estimated at \$xxx
- The packaging of the two die by Knowles is assumed to take place in the xxxx plant in xxx.
 - The packaging cost is estimated at \$xxx
- The component manufacturing cost range from \$xxx to \$xxx according to yield hypotheses.



	Low Yield		Middle Yield		High Yield	
	Cost	Breakdown	Cost	Breakdown	Cost	Breakdown
Clean Room	\$25.01	8.0%	\$25.01	8.0%	\$25.01	8.0%
Equipment	\$84.00	26.0%	\$84.00	27.0%	\$84.00	27.0%
Consumable	\$84.76	26.0%	\$84.76	27.0%	\$84.76	27.0%
Raw wafer (Si)	\$20.00	6.0%	\$20.00	6.0%	\$20.00	6.0%
Salary	\$32.17	10.0%	\$32.17	10.0%	\$32.17	10.0%
Yield losses	\$19.40	6.0%	\$19.40	6.0%	\$19.40	6.0%
UNPROBED WAFER COST	\$274.25		\$274.25		\$274.25	

MEMS Wafer Cost Breakdown (Middle Yield)



- The wafer cost
- The main parts of the wafer cost
- The salary cost
- Details of the cost per step are given in the Excel Spreadsheet.

Material Name	Material Cost	Breakdown
NH3	\$1.70	0.7%
CH3COOH	\$1.20	0.5%
SF6	\$0.80	0.3%
HNO3	\$1.00	0.4%
Al Target	\$1.20	0.5%
Implant phosphore	\$1.00	0.4%
Slurry Si	\$1.20	0.5%
H3PO4	\$1.00	0.4%
Power	\$1.20	0.5%
O2	\$0.80	0.3%
Acetone	\$1.20	0.5%
HCl	\$1.20	0.5%
Developer	\$1.20	0.5%
C4F8	\$1.20	0.5%
DI Water	\$1.20	0.5%
SiH4	\$1.20	0.5%
HF	\$1.20	0.5%
Photoresist	\$11.20	4.7%
TOTAL	\$24.70	10.0%

Microphone Materials Cost

- The main part of the material cost is due to the lithographies steps. The xx masking steps explain this result.
- Details of the material cost per step are given in the Excel Spreadsheet.

