H1 東北大学とベルギー IMEC (Interuniversity Micro Electronics Center)

← 数井 東北大理事と Luc Van Den Hove IMEC社長

協定調印式(2012/6/11)中央はベルギーのフィリップ皇太子 →

IMECでの共同セミナ(2012/6/21)毎年交互開催

H2　Poly-SiGe の MEMS センサ応用

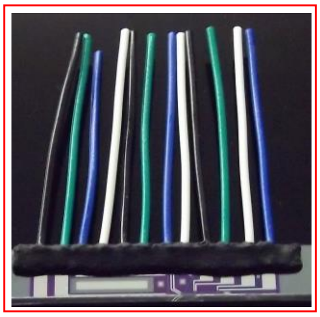
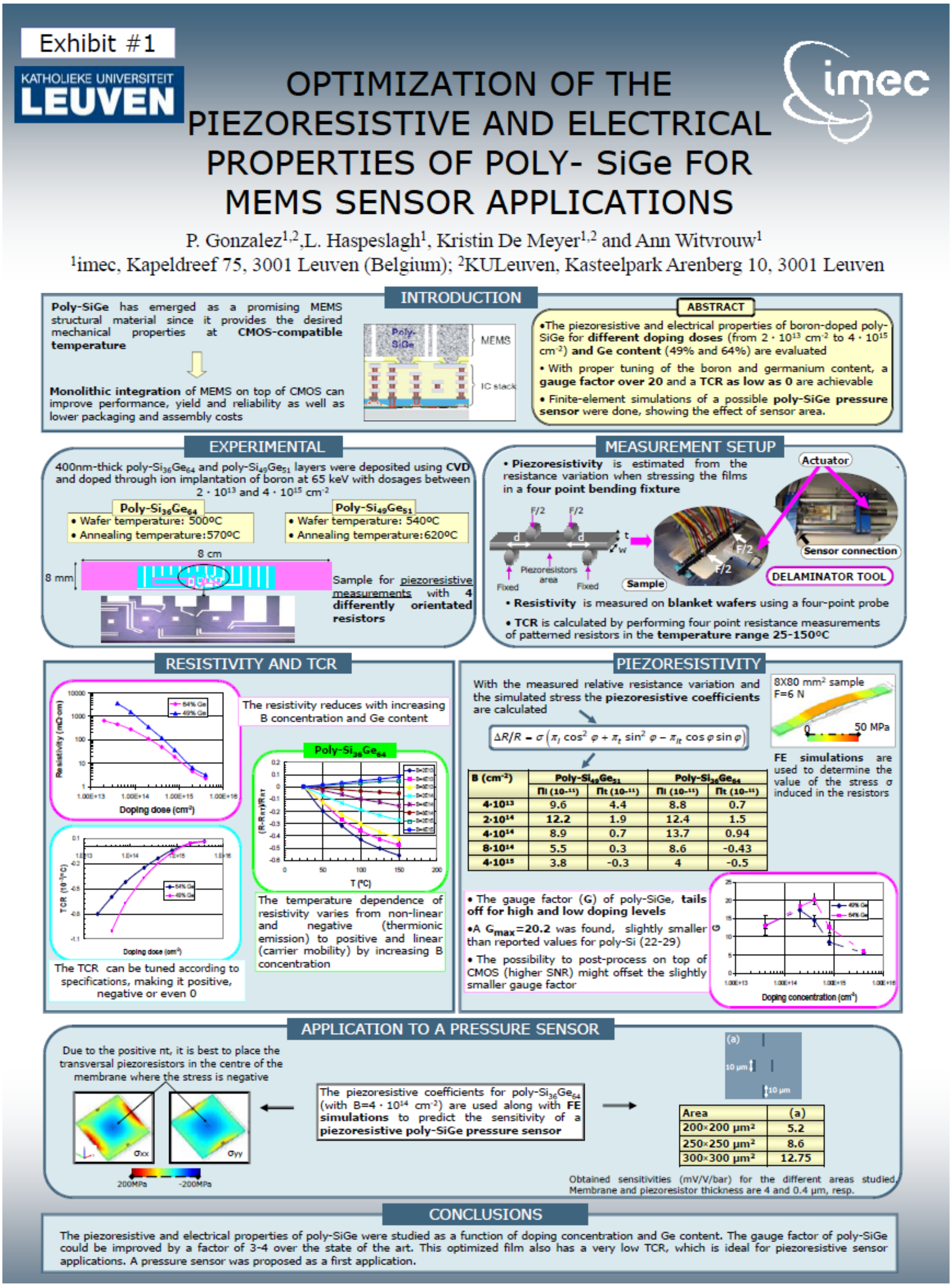


Exhibit #1: Sample to determine the piezoresistivity of a poly-SiGe layer by measuring the resistance changes during 4-point bending tests.



H3　Poly−SiGe を用いた CMOS IC 上の MEMS ジャイロ

ISSCC 2005 / SESSION 4 / TD: MIXED-DOMAIN SYSTEMS

4.7 Processing of MEMS Gyroscopes on Top of CMOS ICs

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[1]IMEC, Leuven, Belgium, [2]ASM, Leuven, Belgium, [3]IMSE-CNM, Sevilla, Spain, [4]Philips, Böblingen, Germany, [5]Bosch, Gerlingen-Schillerhöhe, Germany

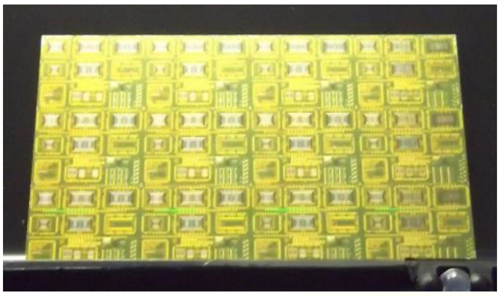
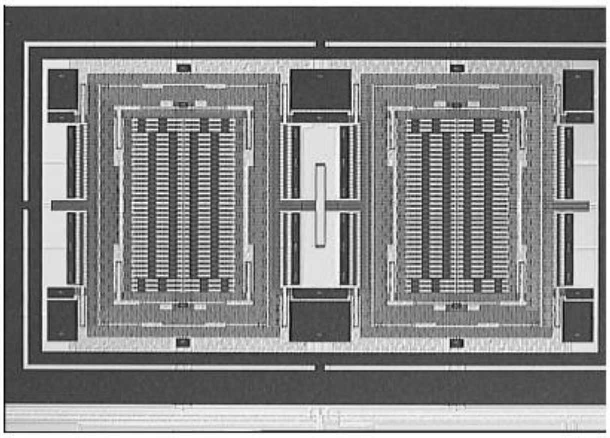
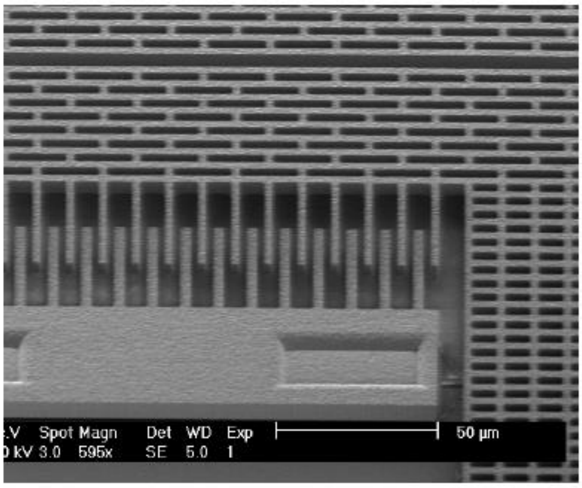
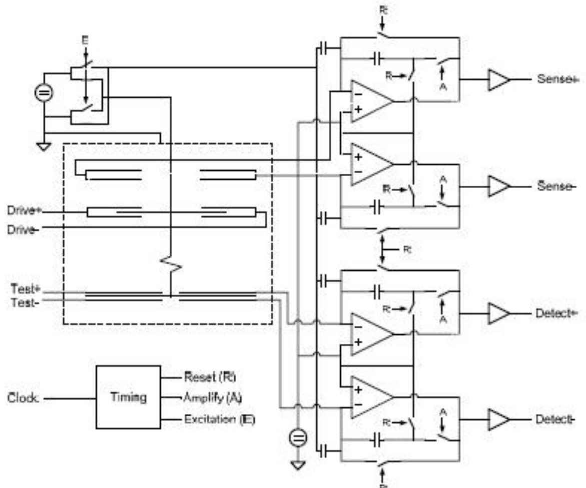
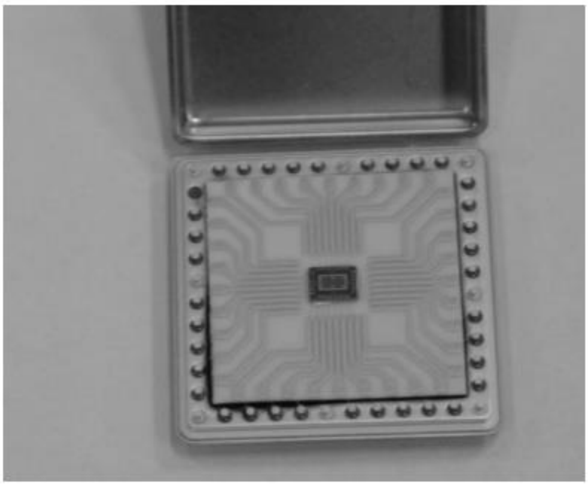


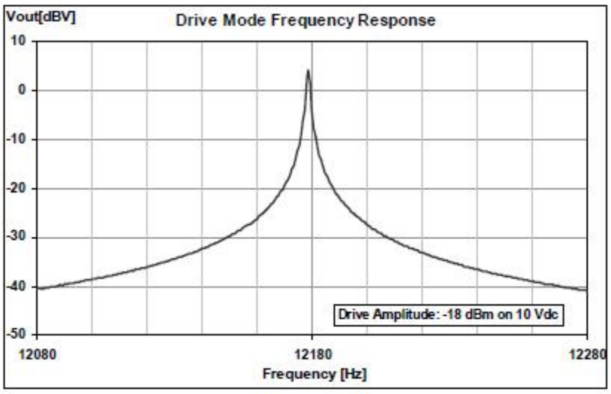
Exhibit #2: First poly-SiGe above-CMOS integrated gyroscope. The CMOS technology used is a standard 0.35 μm technology with 5 interconnect levels.

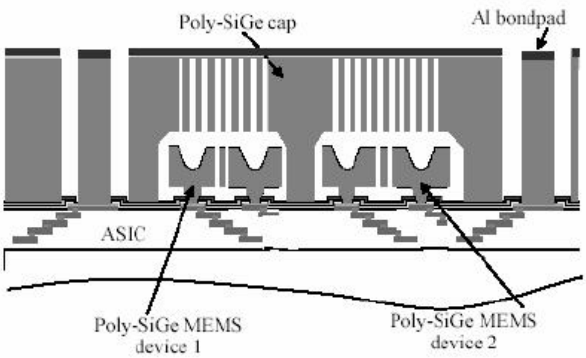












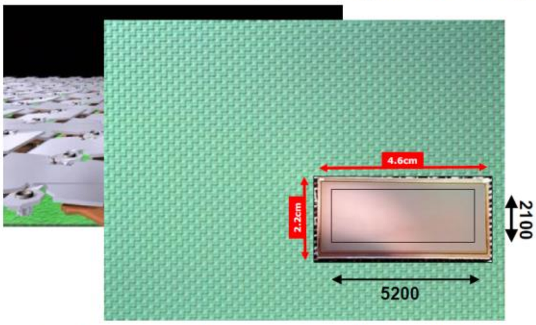
H4 # CMOS IC 上 SiGe ミラーアレイ

Ann Witvrouw

Exhibit #3: 11 megapixel micro-mirror array with 8 μm pitch made in poly-SiGe above standard 0.18μm analog-CMOS wafers fabricated by NXP, featuring 6 interconnect levels.

11MPixel micro-mirror array

- To be used as SLM (Spatial Light modulator)

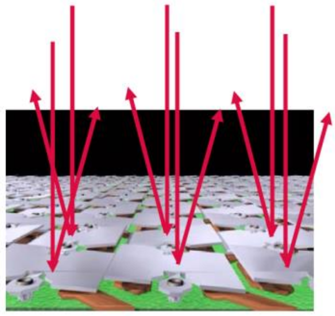


Project together with ASML, Bruco, NXP, Philips Appl. Tech.

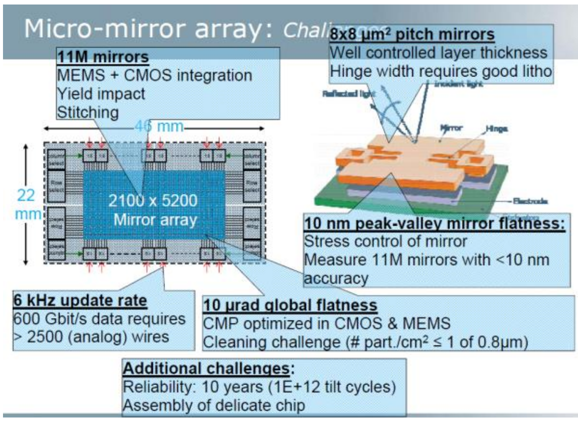
11MPixel micro-mirror array: *application*

Spatial Light Modulator:

- Light is deflected by each mirror to create image
- Applications: video projection, mask writing, maskless imaging

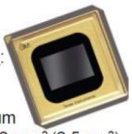


Micro-mirror array: *Challenges*



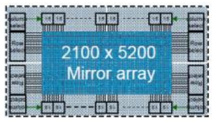
Micro-mirrors: *State-of-the art*

TI DLP Discovery 4000:
1920x1080 (2M)
Digital
Mirror Pitch 10.8 μm
Mirror Area 21 x 12 mm² (2.5 cm²)
<www.dlp.com



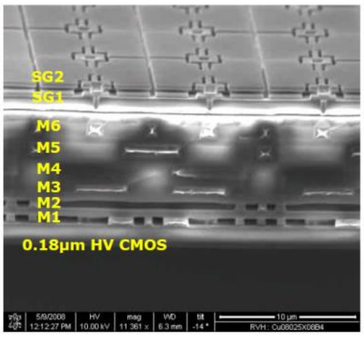
Fraunhofer SLM:
2048x512 (1M)
Analog
Mirror Pitch 16 μm
Mirror Area 33 x 8mm² (2.6 cm²)
<www.ipms.fraunhofer.de

This work:
5200x2100 (11M)
Analog
Mirror Pitch 8 μm
Mirror area 42 x 17 mm² (7 cm²)



Micro-mirrors: *processing*

SiGe is chosen to achieve required mirror specs including reliability at CMOS-compatible T



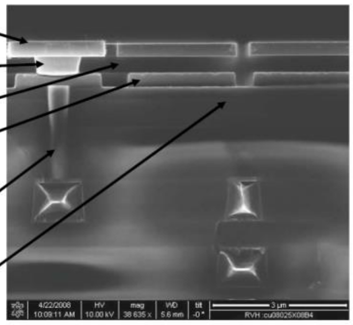
SiGe-based micro-mirror module

Planarised interface

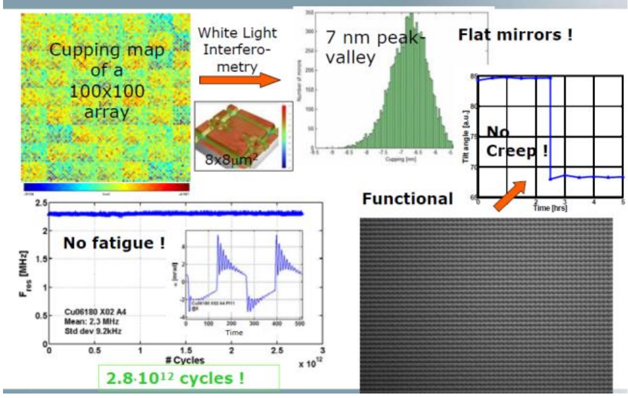
0.18 μm analog CMOS with 6 metal levels (from NXP)

< L. Haspeslagh et al., Proc IEDM 2008

Micro-mirrors: *processing*



Micro-mirrors: *functional & reliability analysis*



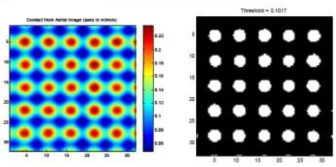
Micro-mirrors: *packaging and testing*

Packaging and assembly
A. Witvrouw et al, Proc. MEMS09

Mirror performance after packaging
123648 mirrors tested

Item	Specification	Results
Good Mirrors %	/	99.5 %
Mean Cupping	< 10 nm	5.4 nm
Residual Piston	< 1nm	< 1 nm

Direct imaging:
3 mirror contact holes



Imaging results: J. Lauria et al, Microel. Eng. 86, 569–572 (2009)

CMORE SiGeMEMS マルチプロジェクトウェハ

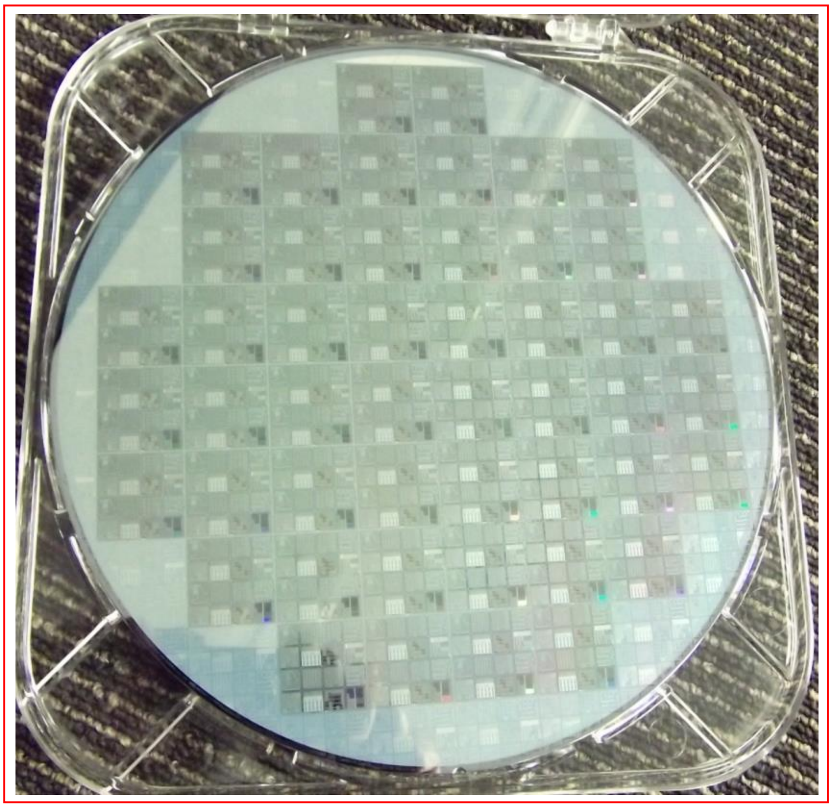


Exhibit #4: Poly-SiGe MEMS MultiProject Wafer (MPW) from the first SiGeMEMS MPW run organized by Europractice in 2011.

EUROPRACTICE IC SERVICE

imec

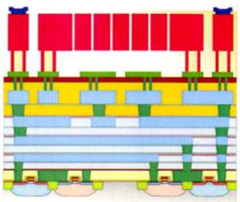
imec CMORE SiGeMEMS MPW

EUROPRACTICE IC Service offers Multi-Project Wafer Services in imec's CMORE SiGeMEMS standalone and SiGeMEMS/CMOS integrated technology:

Imec's **CMORE Silicon Germanium MEMS** platform technology, referred to as **SiGeMEMS**, is developed to enable monolithic integration of CMOS and MEMS. Systems integrating MEMS devices with the driving and readout electronics on the same die lead to better performances in terms of signal to noise ratio through reduced interconnect parasitic resistance and capacitance, allow for smaller die size and package, and also for lower power consumption. SiGeMEMS is based on a MEMS-last approach which allows state-of-the-art CMOS foundries to be employed.

Technology

The SiGeMEMS process, belonging to imec's CMORE service platform, is very versatile. Thanks to its flexible and modular approach, allowing application-specific tuning and optimization, it addresses a large number of applications like gyro's, switches, µmicrophones, µspeakers, CMUTs, T-sensors, P-sensors, ... and array type devices like µmirrors, probe-based memories, and arrays for µfluidics and µpower generation...



EUROPRACTICE now offers a fixed baseline SiGeMEMS process in a Multi-Project Wafer Service. This unique baseline process consists of MEMS structures defined by an electrode layer and a 4µm-thick SiGe-mechanical layer on top of a TSMC 0.18um CMOS wafer. Nanogaps of 500nm will allow fabrication of extremely small features. A standalone MEMS version, identical but processed on a wafer with a single metal layer, will be available for initial prototyping.

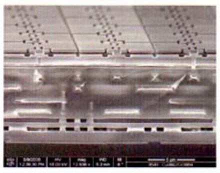
Europractice-imec SiGeMEMS MPW runs in 2012

imec CMORE	2012											
	J	F	M	A	M	J	J	A	S	O	N	D
SiGeMEMS MEMS-only								20				
SiGeMEMS/TSMC 0.18µm CMOS (CV018LD 1.8/3.3/32V)						10				25 [1]		

Note: 1) This run is preliminary and can be updated during 2012

Price

Technology Version	Standard Price	EU-Discounted Price
MEMS-only	4250 €	4000 €
CMOS integrated	28500 €	27000 €



EU-Discounted Price only applies to EUROPRACTICE registered (who paid their annual full membership fee) Academic and Research Members from all 27 EU countries and Norway, Iceland, Liechtenstein, Israel, Croatia, Serbia, Macedonia, Albania, Montenegro, Bosnia&Herzegovina, Switzerland, Turkey who submit designs for *educational or publicly funded research use only.*

Standard Price normal price for universities and research institutes not belonging to previous category. (Companies should contact imec CMORE at www.imec.be/cmore to take advantage of additional extensions and services.

Prices and conditions may change at any time without prior notice

For more information : epmems@imec.be www.europractice-ic.com

EUROPRACTICE IC SERVICE

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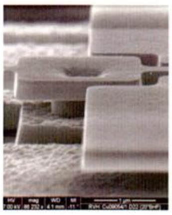
imec CMORE SiGeMEMS MPW

Principle

Imec's CMORE SiGeMEMS technology offered through the EUROPRACTICE IC MPW service is aimed at creating, characterizing and evaluating test structures prior to further specific development and production projects. By gathering the designs of multiple customers on the same masks set, MPWs allow to fabricate test structures and prototypes of devices at a low cost.



Advantages of SiGeMEMS

Monolithic integration with IC :

- Very compact
- Best solution for applications that are very sensitive to parasitics
- High intrinsic system reliability: less components, less interconnections.

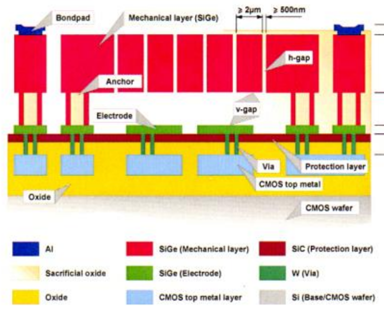
MEMS last above CMOS :

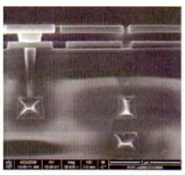
- Most flexible with respect to choice of CMOS technology
- Extremely well suited for MEMS array applications
  - very high-density and massively parallel interconnections possible → large arrays of MEMS (e.g. µmirror arrays)

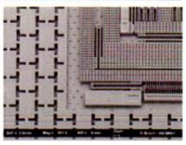
Poly-SiGe :

- High performance: low parasitics
- Good mechanical properties & reliability
  - better than Al: higher strength and Q factor
  - better than Al: less creep and fatigue

Summary of SiGeMEMS main features and dimensions







General conditions :

EUROPRACTICE SiGeMEMS MPW Service is accessible for universities and research institutes. (EUROPRACTICE registered members)
→ more info at www.europractice-ic.com

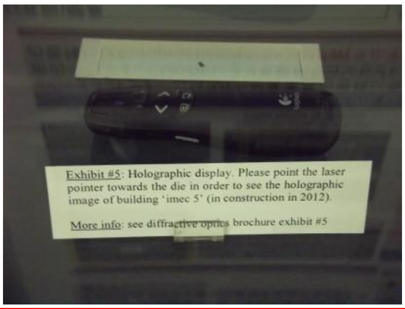
Companies can have additional extensions to take advantage of the versatile, flexible and modular technology:

- Variable layer thicknesses
- Application-specific optimization of layer & material properties
- Application-specific functional add-on layers

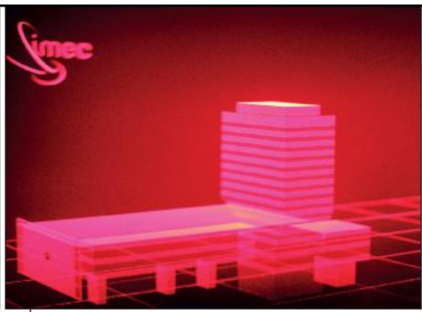
Companies should contact imec CMORE at www.imec.be/cmore

For more information : epmems@imec.be www.europractice-ic.com

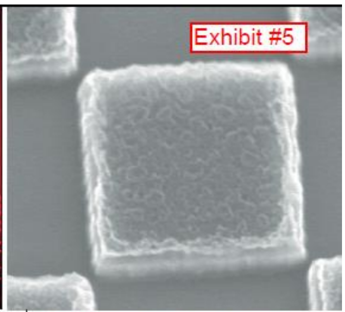
H6 ホログラフィック ディスプレイ



Set-up for holographic display technology.



Holographic image demonstrator.



SEM-image of sub-wavelength binary holographic pixel.

DIGITAL DIFFRACTIVE OPTICS

PATH TO HIGH-QUALITY HOLOGRAPHIC DISPLAYS

Vision

Imagine having a meeting. You and your guests sit around the table arguing, discussing or presenting data. Just like any meeting you have today, only for one detail: some of the people around the table are 3D images – dynamic holograms – of people sitting in an office thousands of miles away. You will look them in the eye, feel their hesitations, and see their body language. Unlike with today's displays, you won't miss a cue.

Holographic visualization promises to offer a natural 3D experience for multiple viewers, without the undesirable side-effects of current 3D stereoscopic visualization (uncomfortable glasses, strained eyes, fatiguing experience). Imec's vision is to design the ultimate 3D display: a holographic display with wide viewing angle and a high-definition visual experience.

Challenges

Building a high-quality, real-time holographic display requires several breakthroughs from today's holographic prototypes. The challenges are threefold:

– To achieve high image quality, millions of light-diffracting elements are needed. These must all be individually controlled.

– To achieve a wide viewing angle, the light-diffracting elements should be sized close to or below the wavelength of the visible light, i.e. as small as a few hundred nanometers.

– To achieve real-time imaging, massive computing power is needed.

Technology

Imec is scaling its MEMS technology to meet these challenging demands. Our prototypes show promising results, setting the path to high-quality displays.

Imec aims for system-level solutions utilizing a unique combination of its multi-disciplinary teams with strong competences in:

- Advanced lithography
- Silicon processing
- SiGe MEMS processing platform
- MEMS design & prototyping
- Computational holography
- Holographic (lens-less) imaging
- Sub-wavelength diffractive optics
- Embedded system design
- Parallel computing platforms

Our longer-term goal is to create a display system for computer-generated holography with billions of sub-wavelength diffractive elements, delivering high-definition 3D visual experience.

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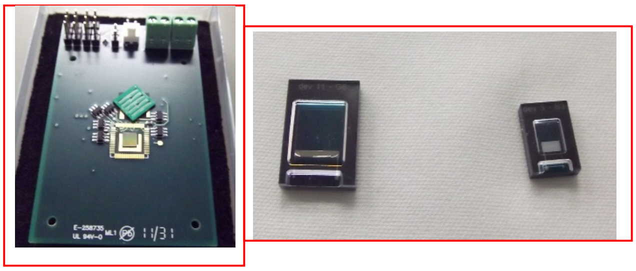
www.imec.be

H7 エネルギハーベスタ用 MEMS と電子嗅覚



エネルギハーベスタ用 MEMS と電子嗅覚

Imec, The Netherlands

Background

Wireless sensor nodes are able to operate autonomously, for extended periods of time, provided they are equipped with Ultra Low Power components, and their energy is supplied by energy harvesters. For both the sensors as well as the harvesters, MEMS fabrication by bulk machining is an enabling technology.

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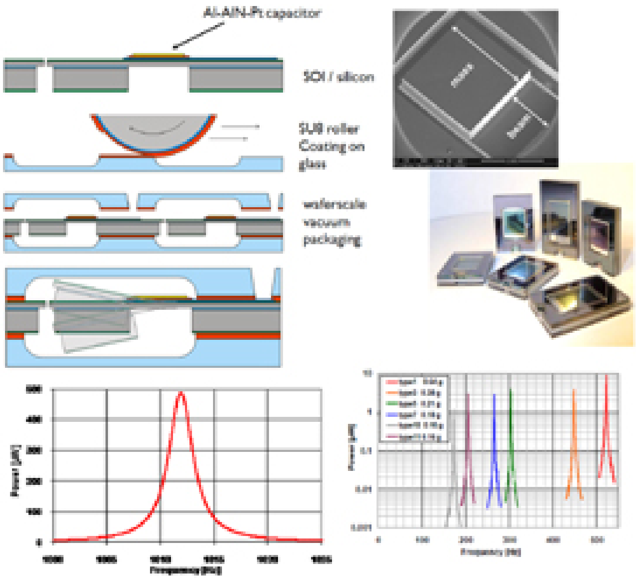
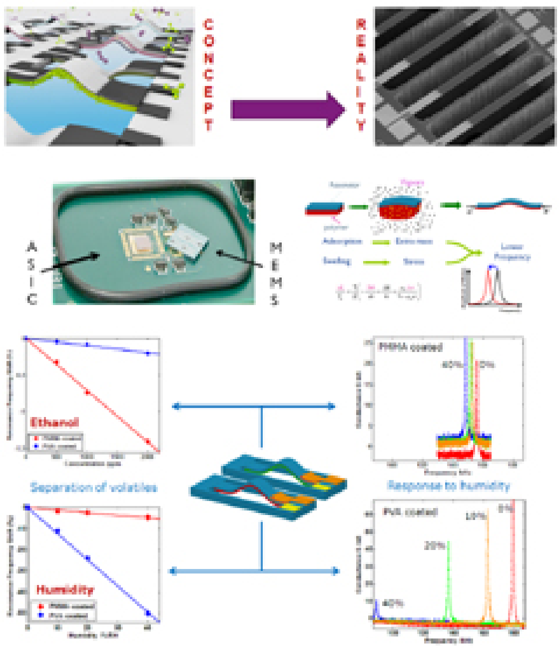
Energy Harvesting

ピエゾ電気による振動発電デバイスは SOI ウェハに作られます。Al-AlN-Pt を堆積した後、DRIE（深い反応性イオンエッチング）によって梁や錘を形成しています。2 枚のガラスウェハで空洞内に真空封止されて作られていますが、この封止にはローラーによるコーティング法を用います。200Hz から 1KHz の異なる共振周波数を持つ複数のものが設計されており、得られた最大電力は 4.5G の加速度の場合 489 μW です。





Ultra Low Power Electronic Nose

MEMS 片持ち梁における分子吸着による共振周波数の変化を用いた、質量変化型の(バイオ)センシングが今まで用いられてきました。

IMEC では MEMS 共振子アレイの共振周波数変化を用いた電子嗅覚を開発しました。これはそれぞれの共振子に異なる種類の高分子膜を付けておき、環境中でそれぞれが異なる応答をすることを利用します。この方法では高分子膜が気体を吸着したときに応力変化を生じて共振周波数が変わります。これは質量変化によるものより 300 倍程高感度で、また MEMS アレイの微細化によって微量の気体が検出できます。このための ASIC 回路も作られて、センサデバイスのピエゾ駆動や、共振周波数に追随することを可能にしています。

Holst Centre