3D DRIE Activities & plans of Alcatel

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3 DIT Workshop Palaiseau Nov. 29th 2007

ALCATEL
Micro Machining Systems

Part of a Worldwide Leader, High Tech, Multinational Corporation

Corporate update: Alcatel-Lucent Merger completed
- World's leading Communication Group
- Annual Revenues: > €18.6 billion* (CY06)
- Employees >79,000
- R&D: €2.7 billion* (CY05); **Bell Labs**

Enterprise Business Group

Vacuum Group
- Annual Revenues: > 200 M€ (CY06)
- Employees >980

100%

Alcatel Vacuum Technology France (AVTF)
JY. GUEGAN

adixen

100%

Alcatel Micro Machining Systems (AMMS)
G. BELLINI

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Outline

- Introduction
- DRIE: Semiconductors and Microsystems
- Majors Achievements
- Trends & perspectives
- Conclusion

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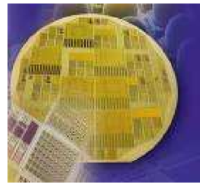
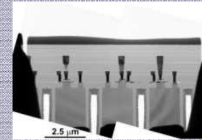
S.C. Etching tools & Microsystems

Semiconductor



1µm technology
RIE

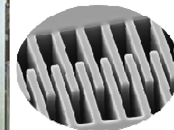


Moore law
Toward nanotechnology

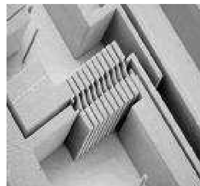
Dry Etch technology expertise

=

Deep RIE Technology
Bosch Process

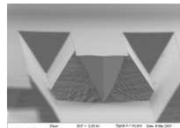


Microsystems



High AR and High ER requirements

100 µ technology
Wet Etch



MEMS Law
One process = one product

1990 — **1993** — **>1998 …..**

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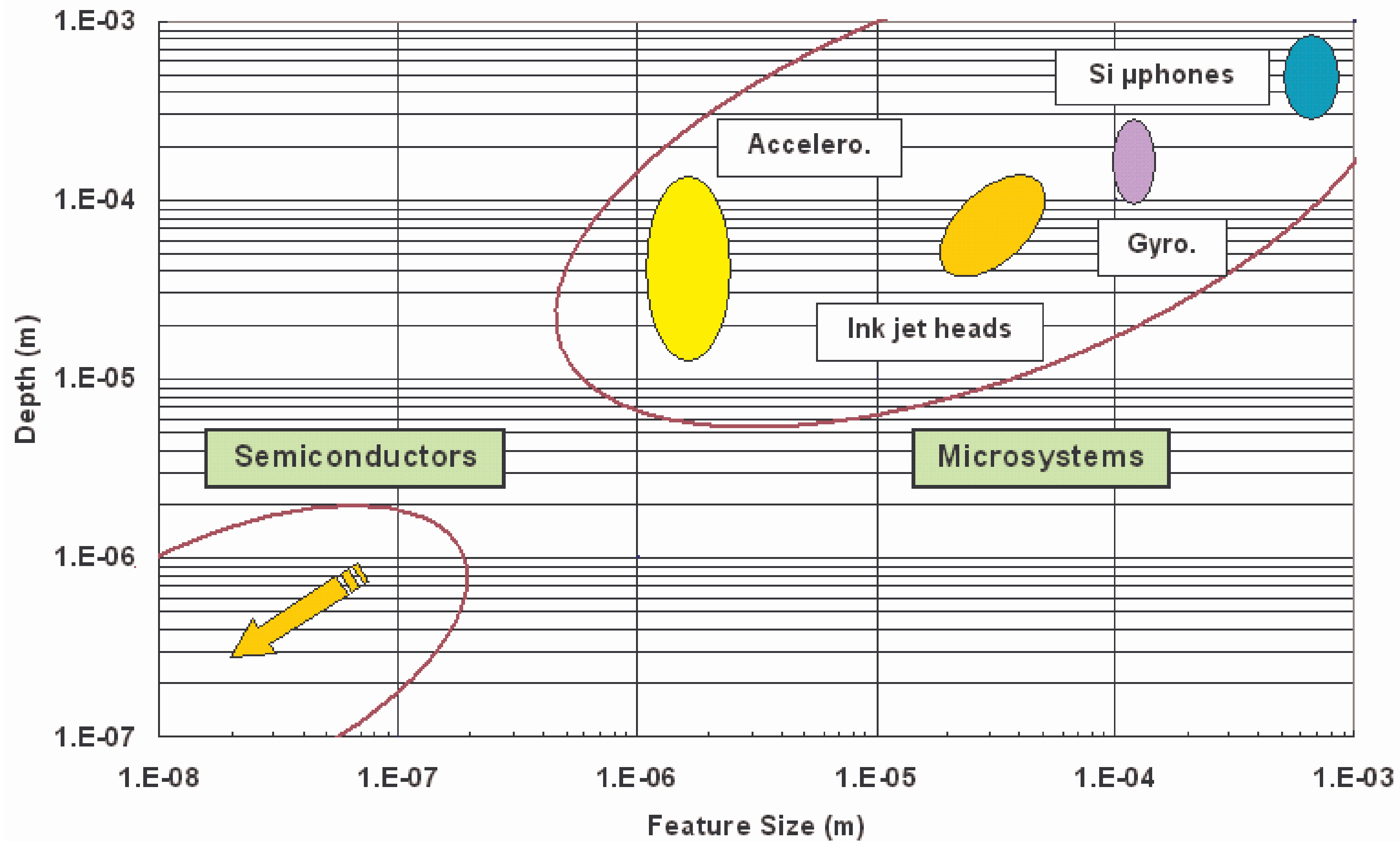
Microsystems & Semiconductors

- Microsystems: a wide range of size & depth !



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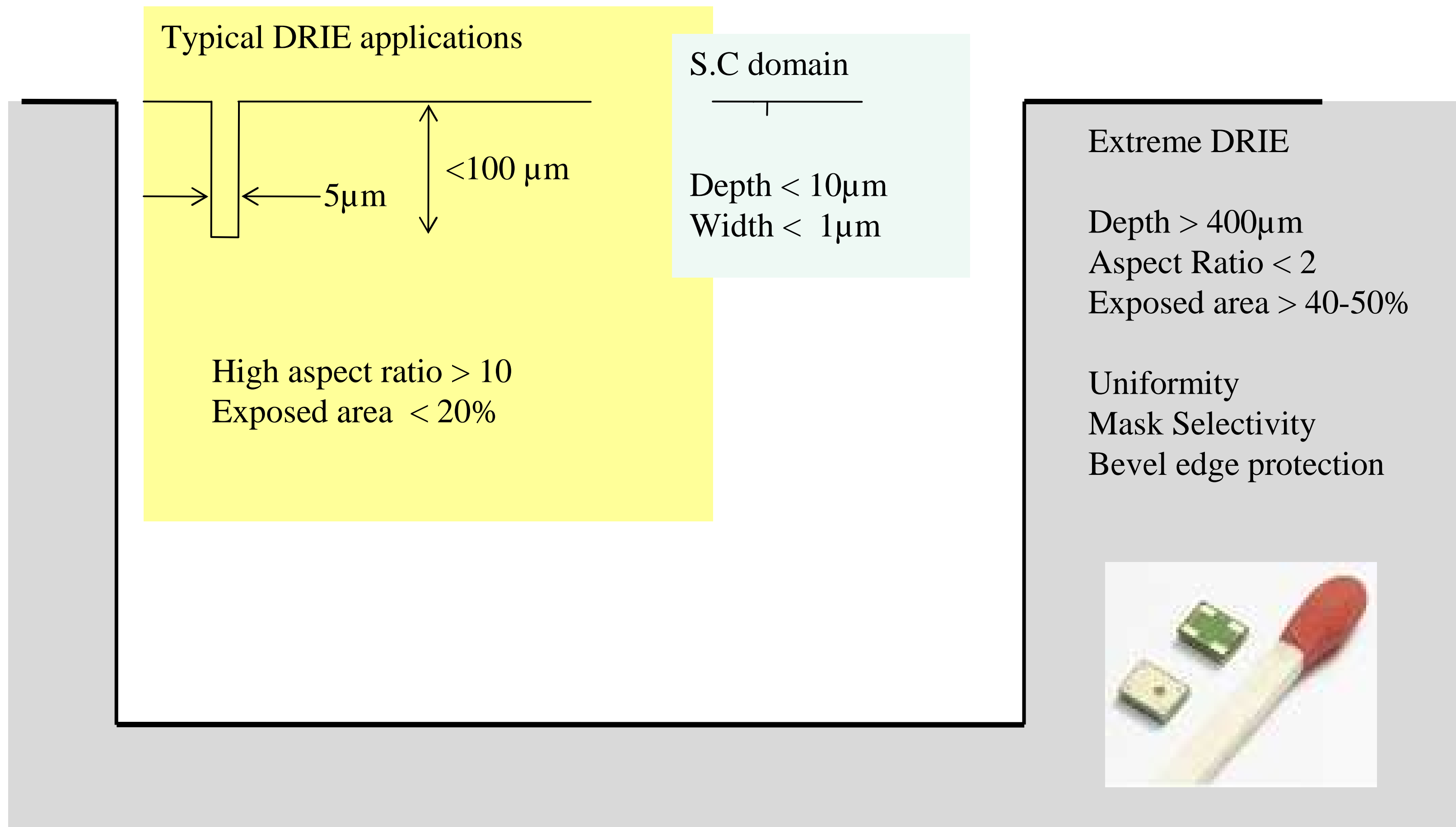
DRIE requirements for MEMS

- Microsystems: a huge volume of Si to remove !



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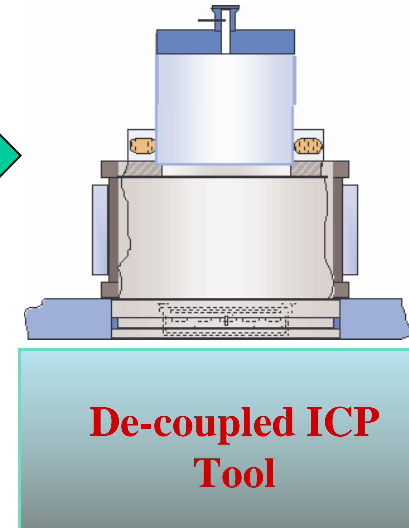
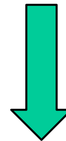
DRIE requirements for MEMS

Very High Selectivity	Low Plasma potential Independent Bias control
Very High Etch Rate	High Density Plasma “F” Chemistry
Anisotropy	Passivation mechanism



De-coupled ICP Tool



Simultaneous etching: with SF6 and sidewall passivation with O2 and Cl2, HBr

OR

Bosch Process: Short cycling steps of isotropic etching with SF6 and Polymer Deposition with C4F8

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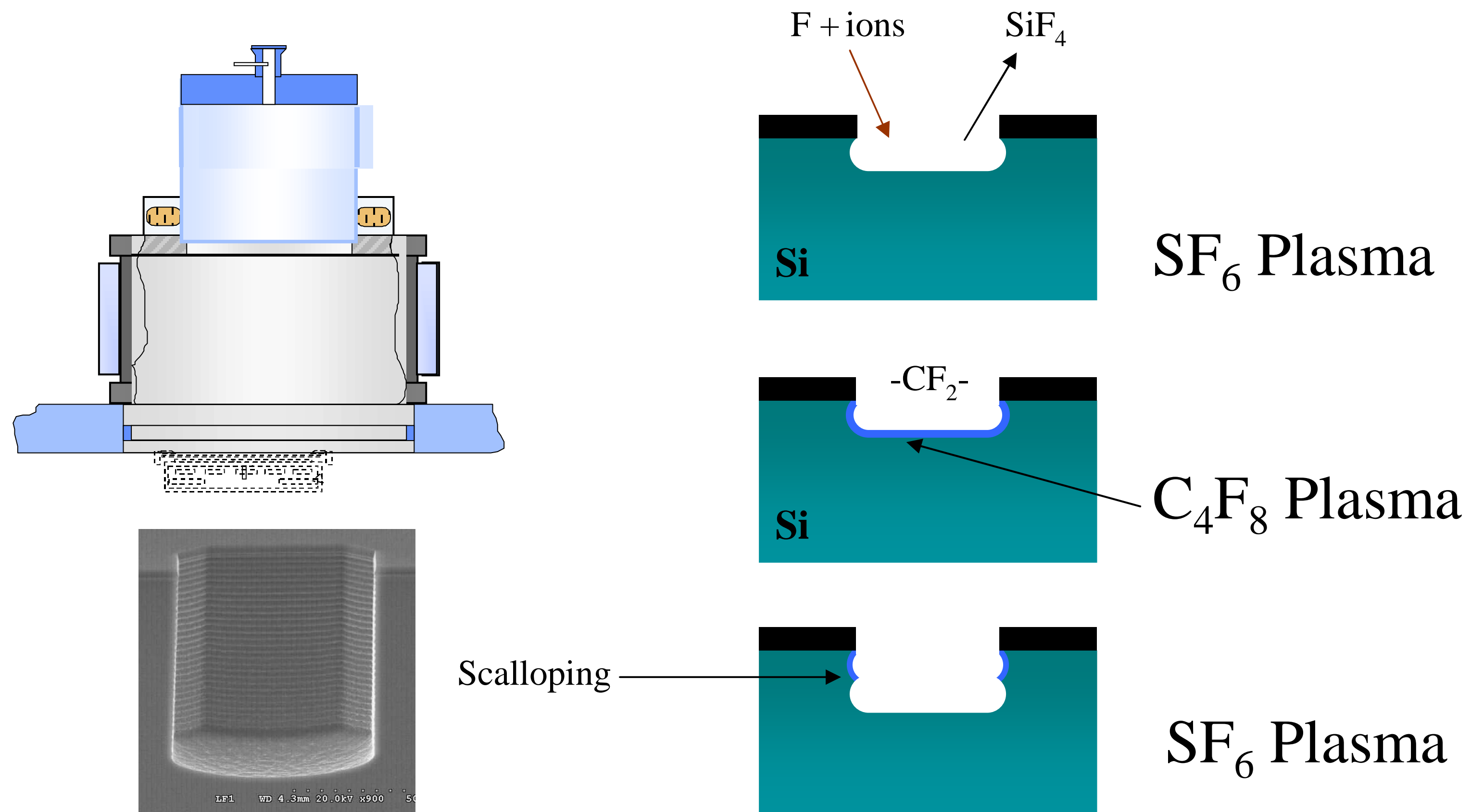
The “Bosch*” Process

- A time multiplexed process between Etch & Passivation



*US pat. 5,501,593 Publi. Mar. 26, 1996

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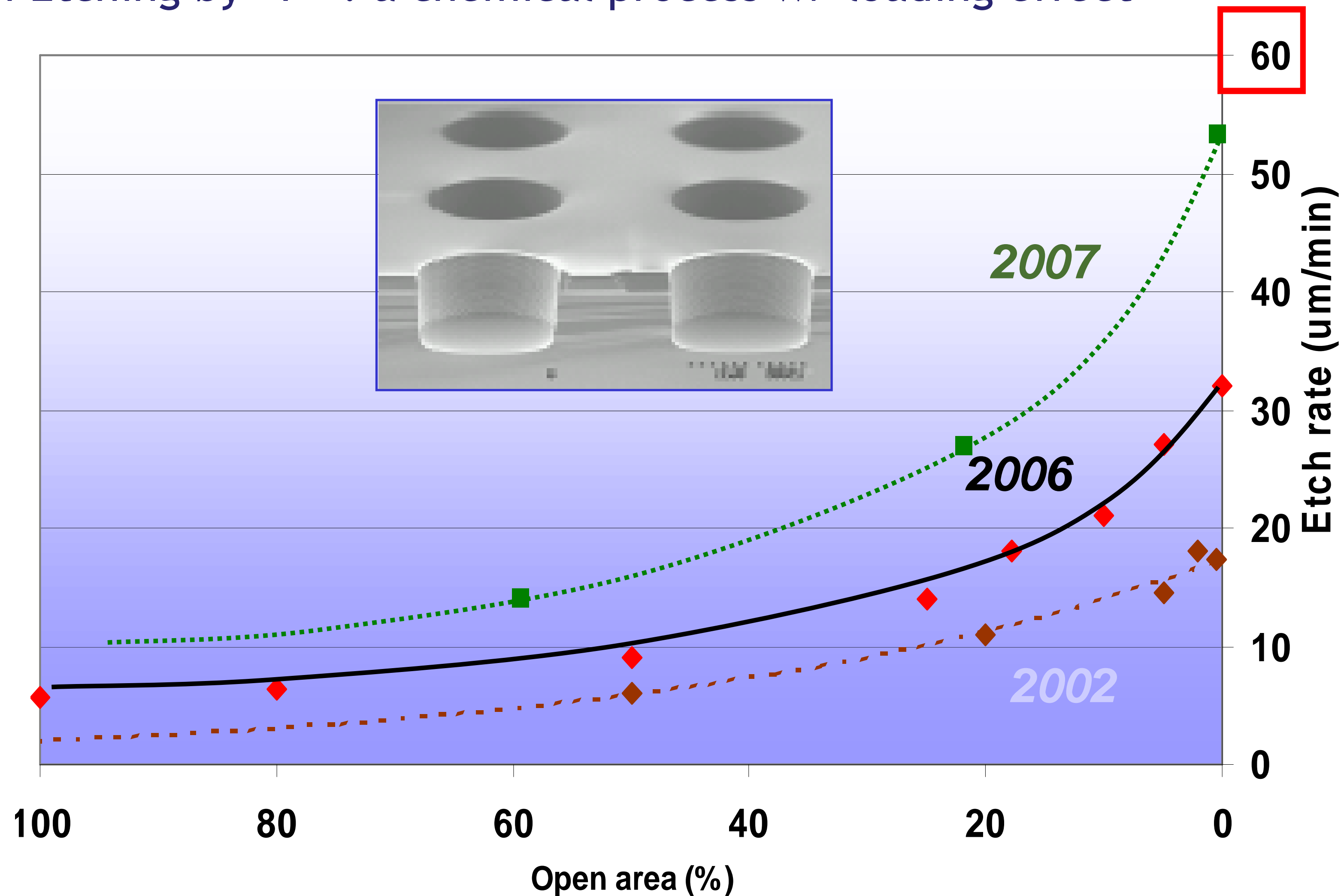
The Race Toward Higher Etch Rate

- Si Etching by “F” : a chemical process w/ loading effect



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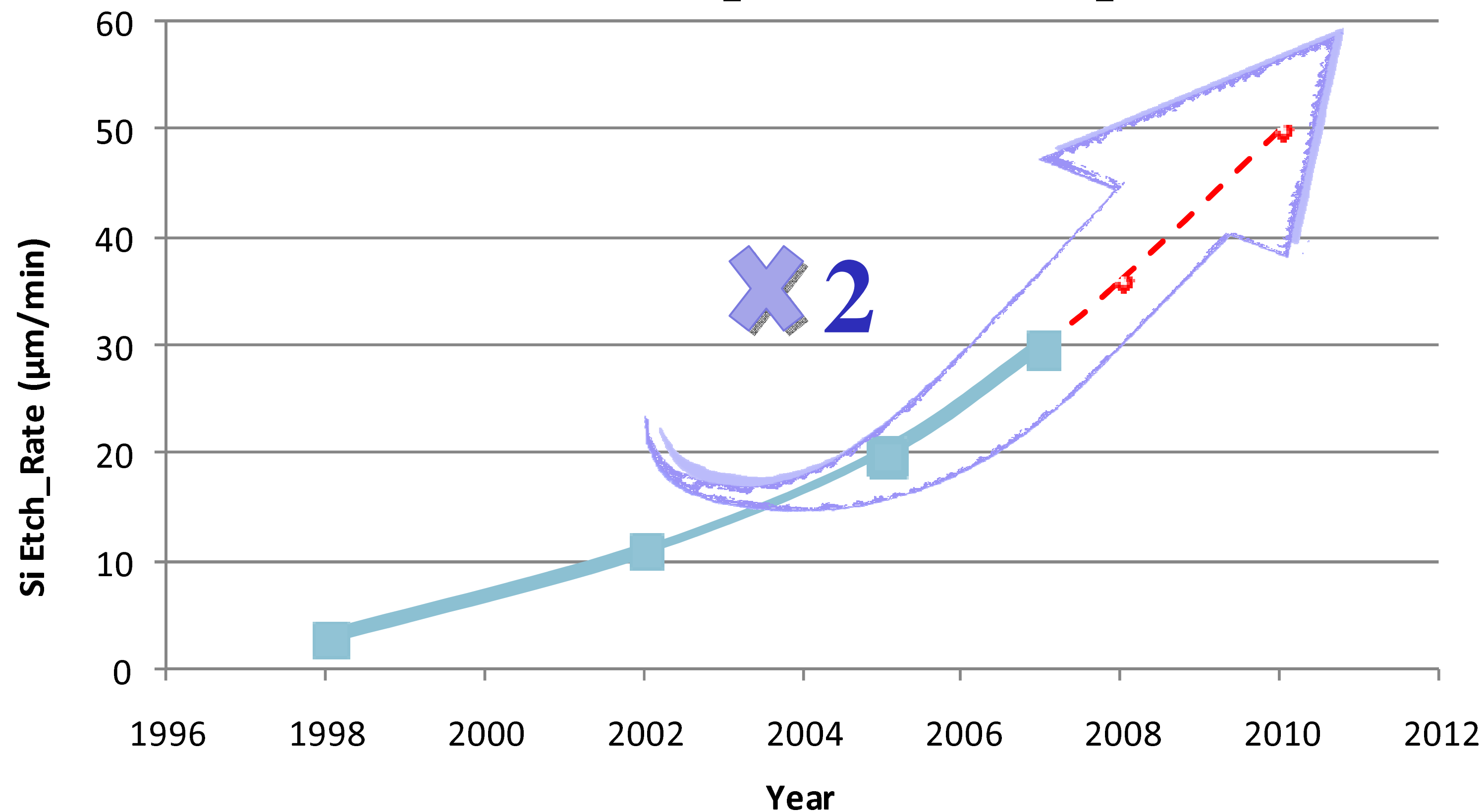
The Race Toward Higher Etch Rate

- Higher gas flow / pressure, Better gas utilization
- Higher RF Power



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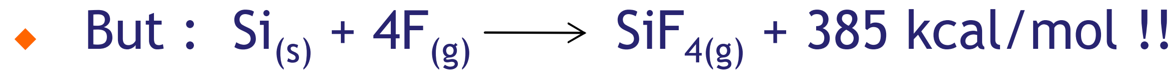
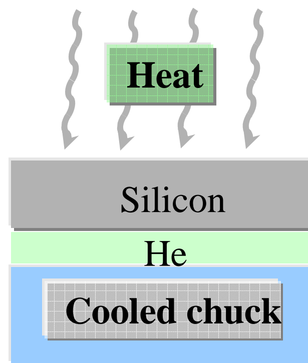
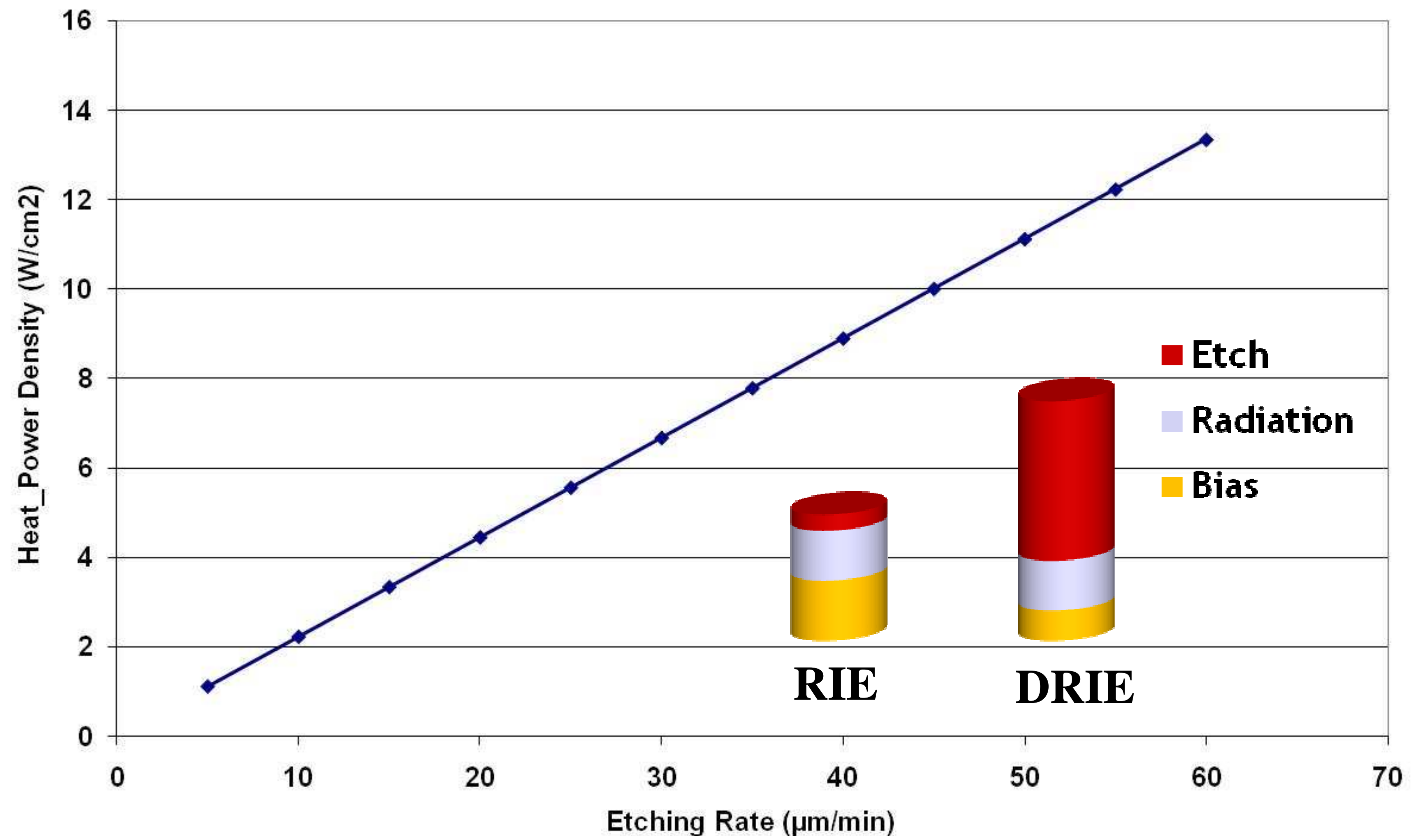
Thermal Budget issues







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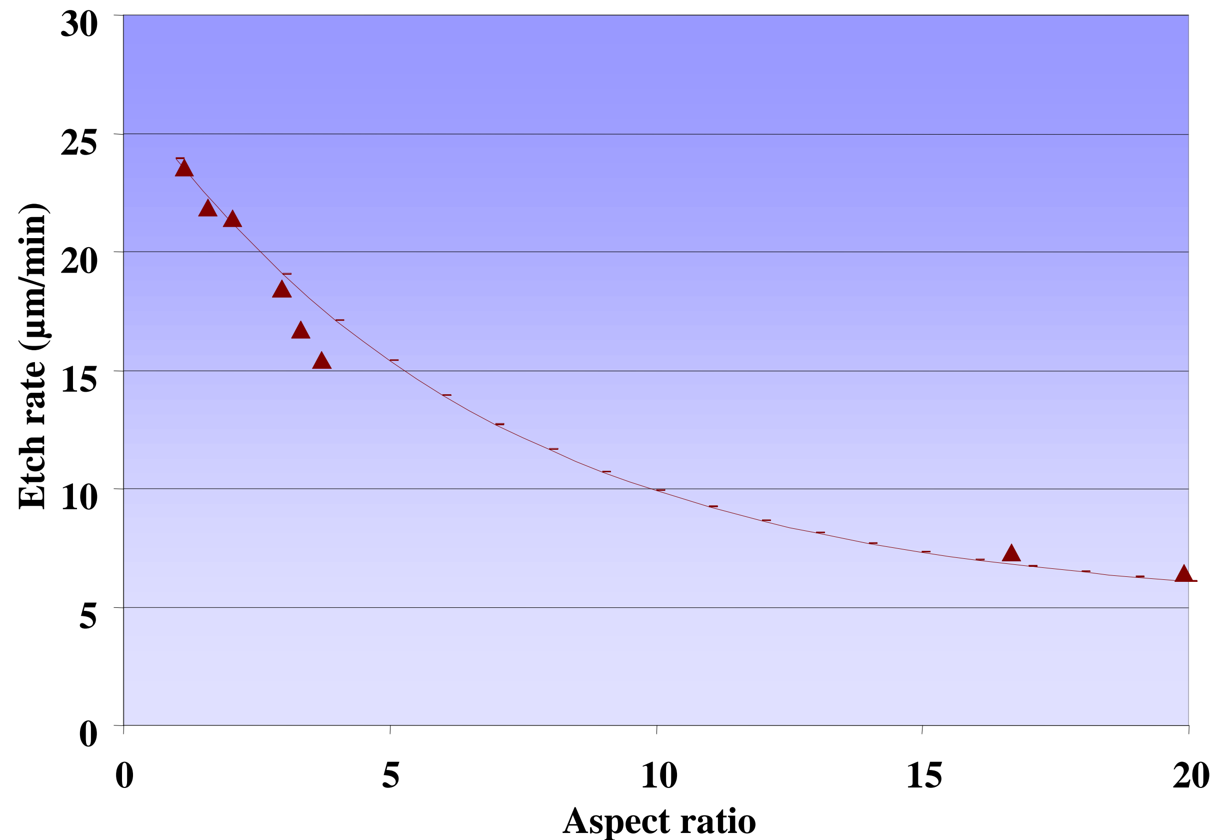
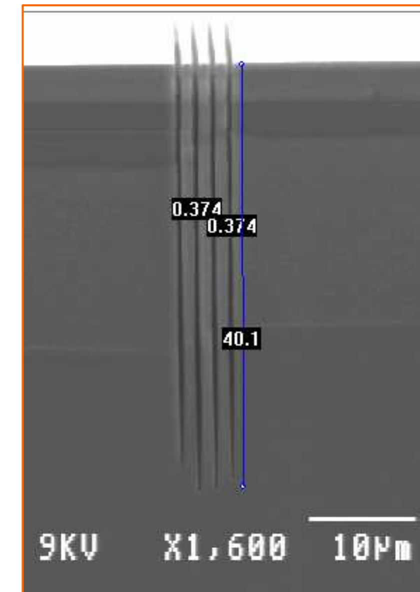
Aspect Ratio Dependent Etching

- Silicon Etch rate is sensitive to Aspect ratio (species transport limitation)





Alcatel Patented process
(S.H.A.R.P. process)
Achieving Aspect Ratio
> 110

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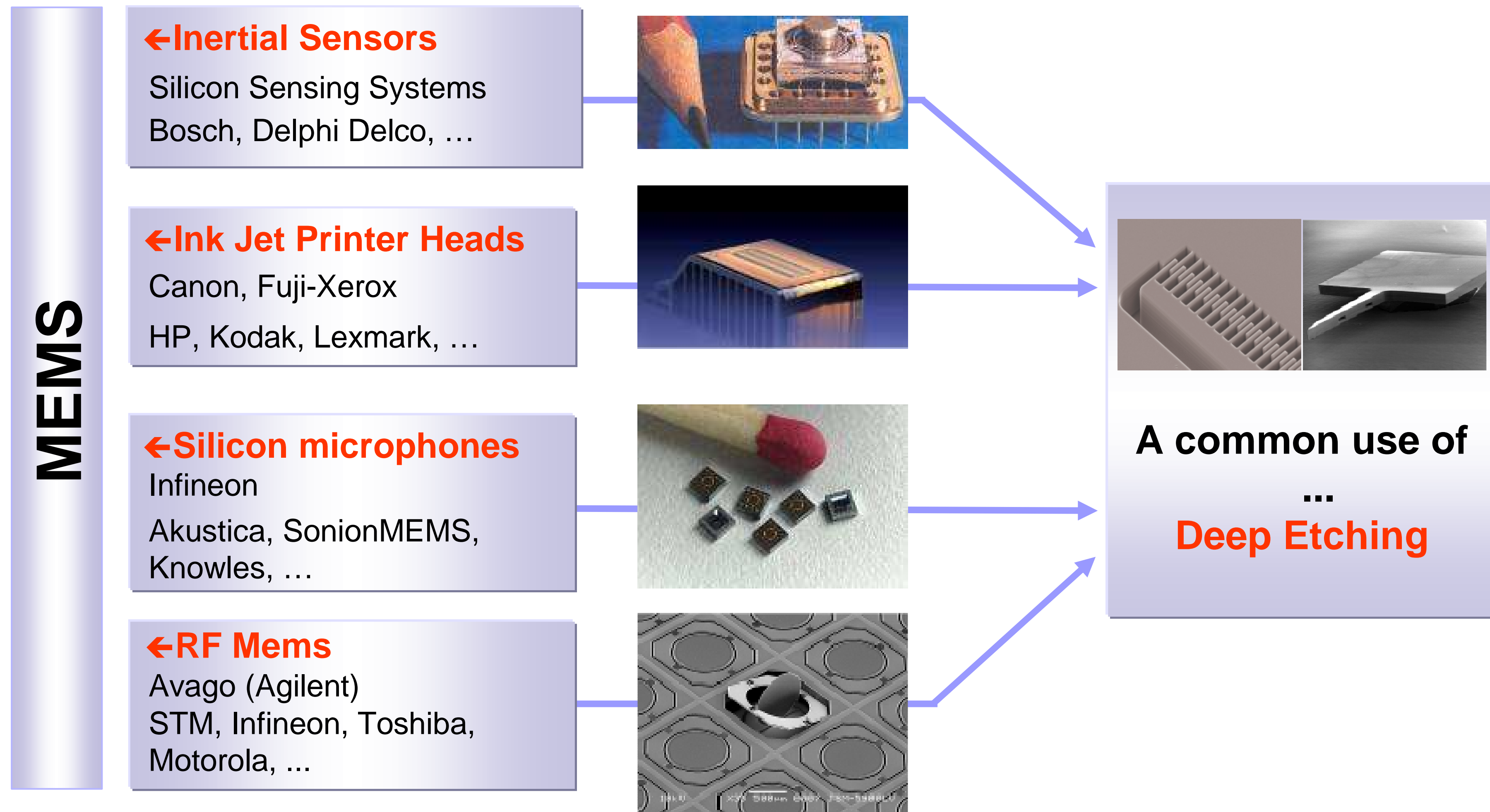
New perspectives for the DRIE

- DRIE: a key technology to address the 3rd dimension



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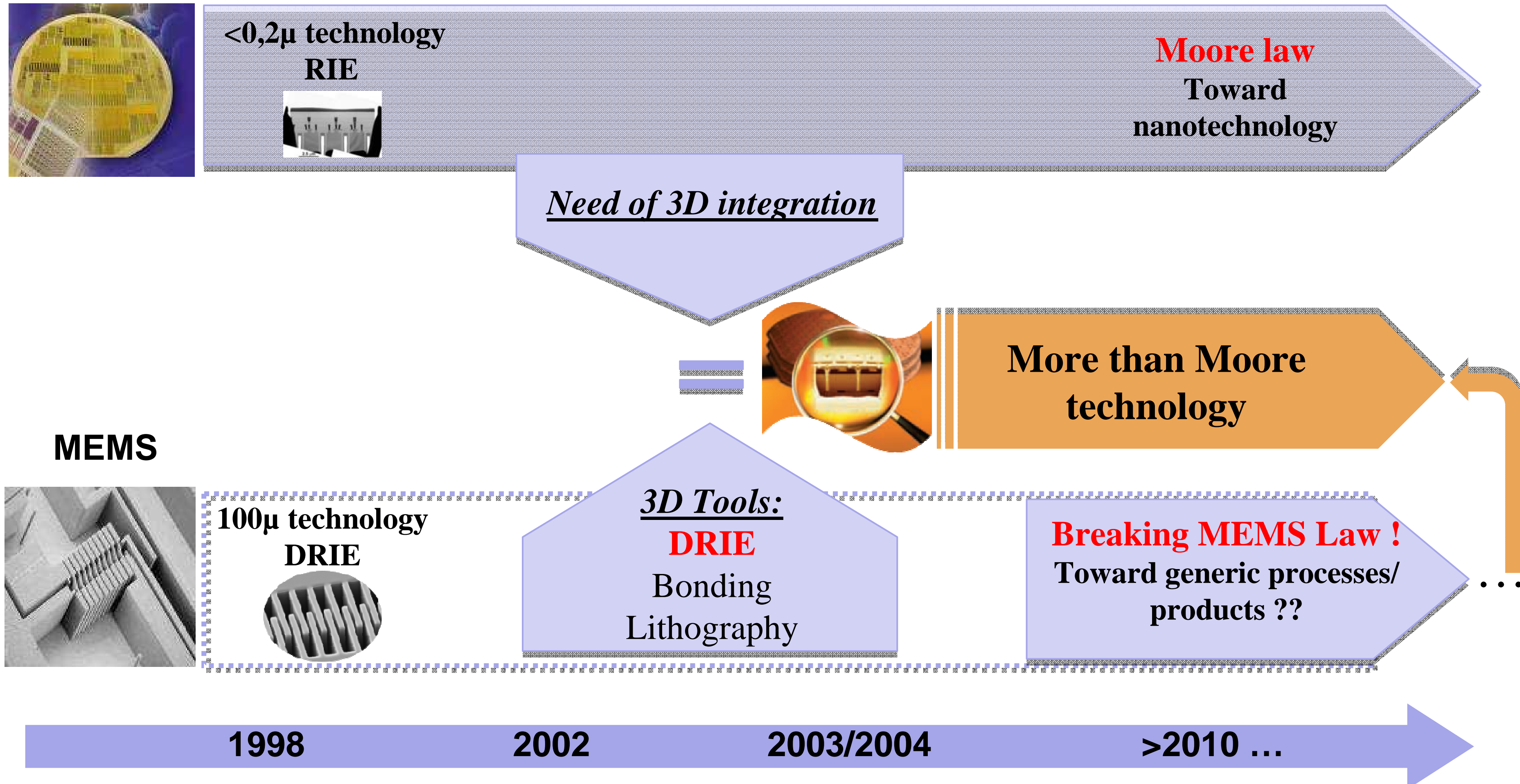
Interest from S.C



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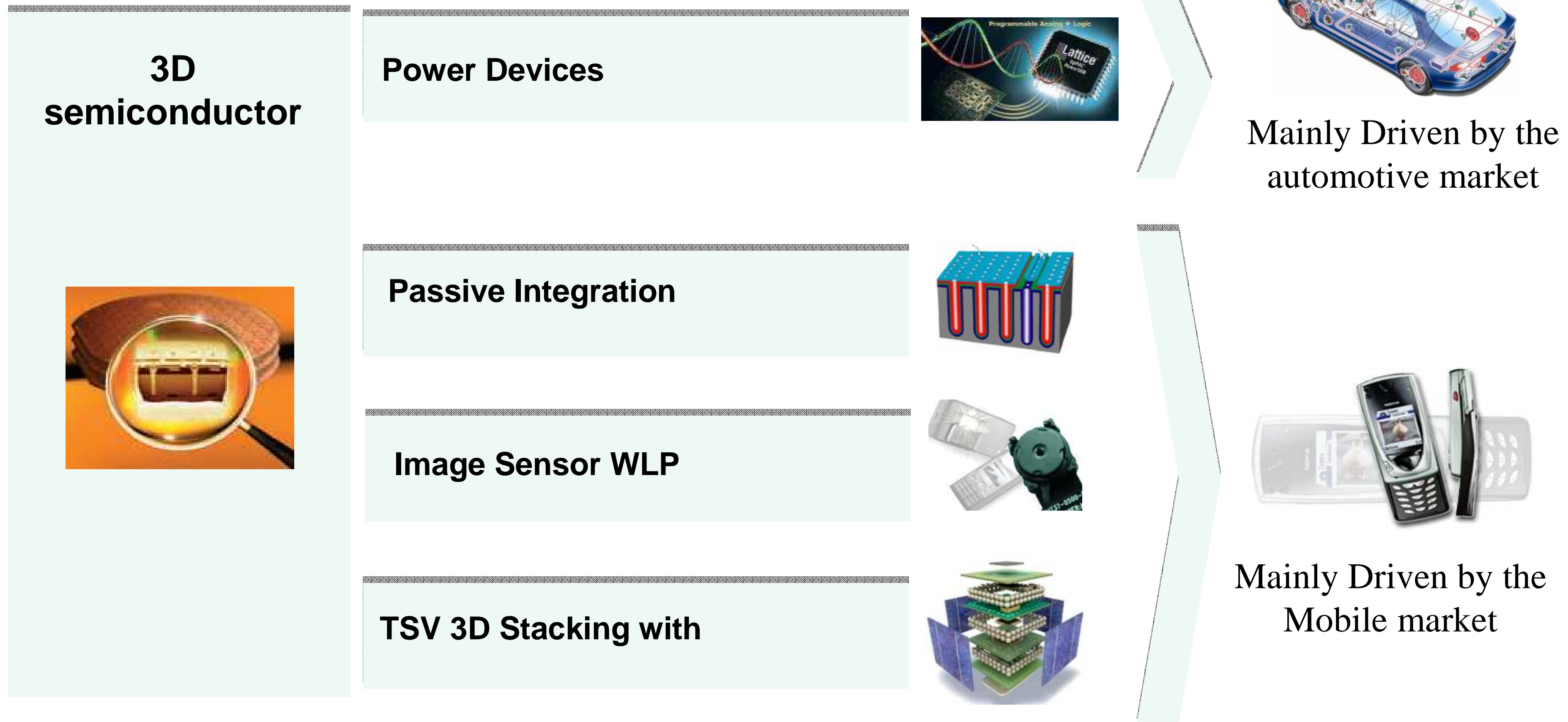
Interest from S.C

- Common need of Deep etching and LT-PECVD :



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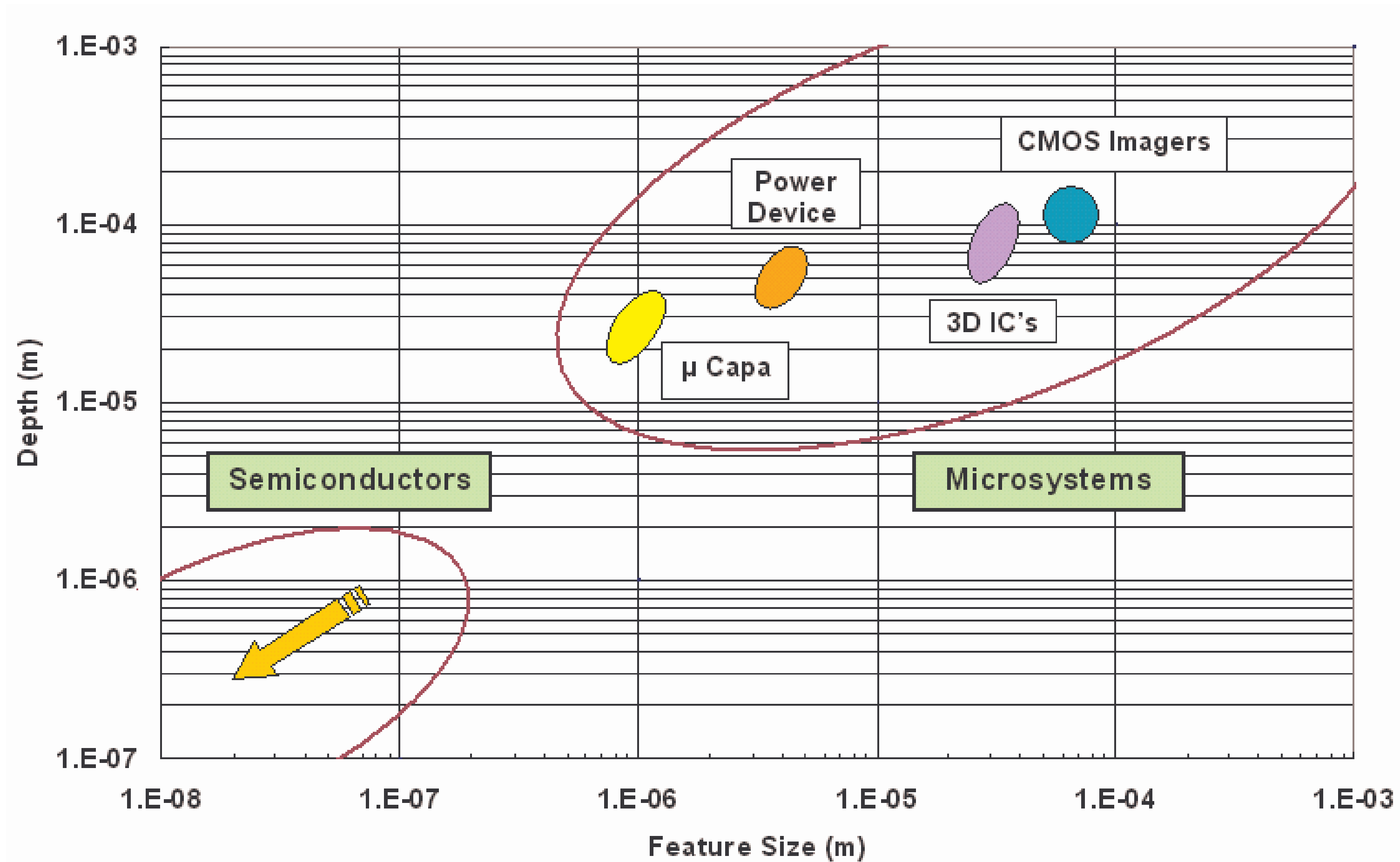
3D SC within the scope of DRIE

- 3D S.C fall into the micro-systems domain !



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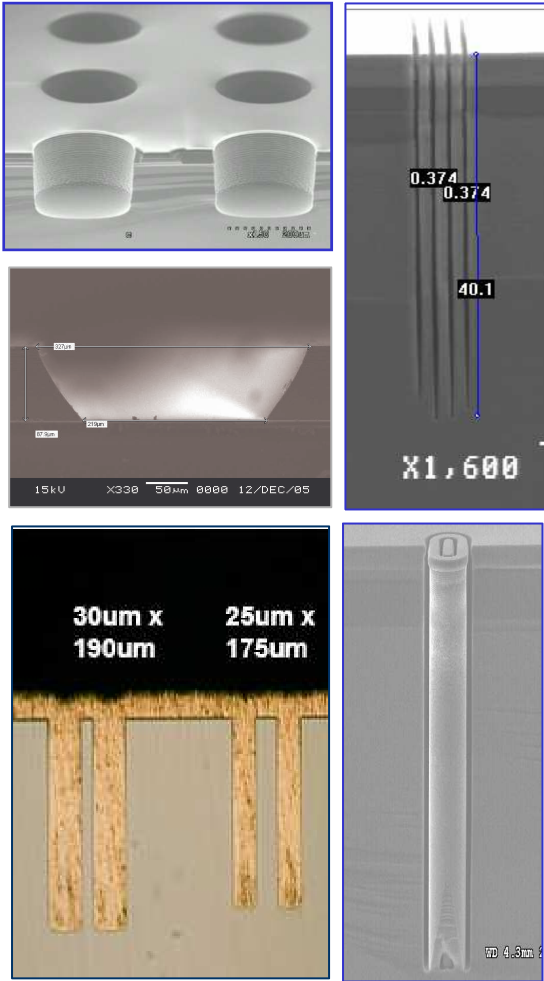
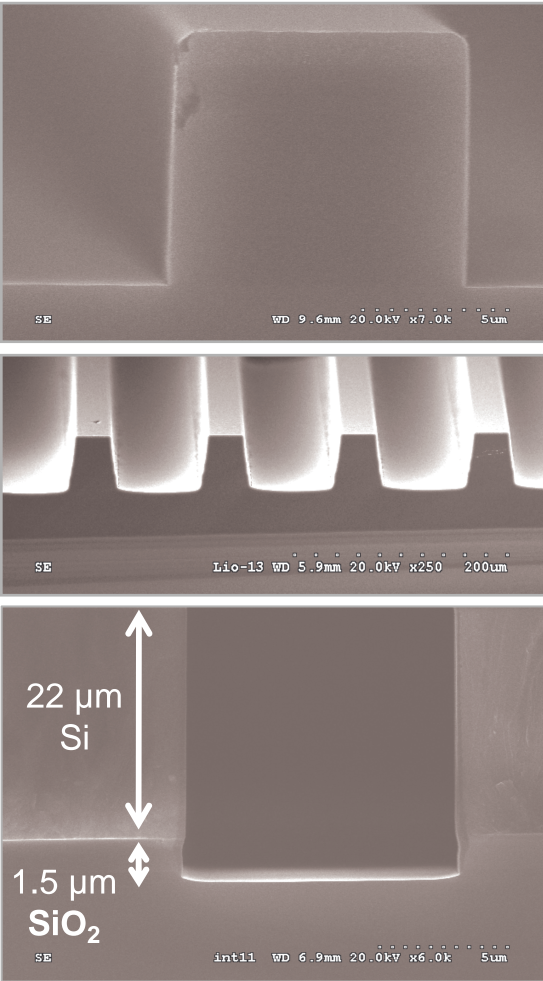
Process Range

… addressing 3D integration applications

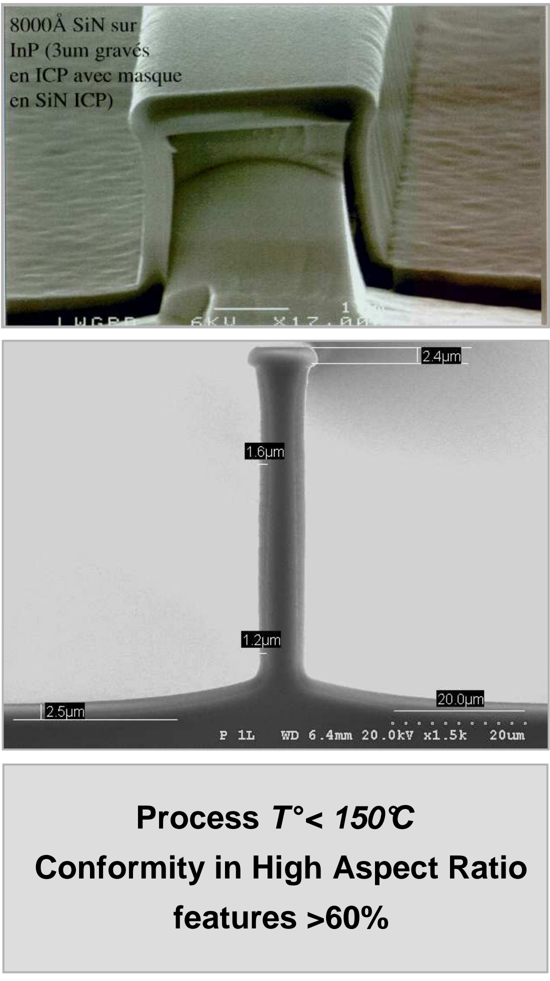
Silicon Via etch



Thick SiO2 Etch



Low Temperature PECVD



Process T°< 150℃

Conformity in High Aspect Ratio features >60%

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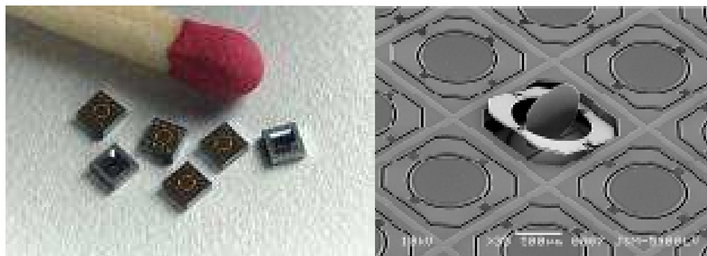
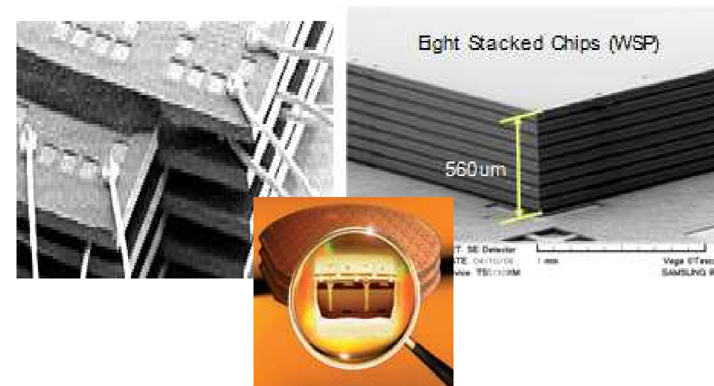
Transition to 300 mm

- 300 mm transition driven by mobile applications

•MEMS
•Power Devices
•Passives integration

•WLP CMOS image sensors
•3D integration/ Device Stacking





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- DRIE of silicon became a key enabling technology for MEMS.
- Within a decade, DRIE increased productivity by almost a factor of 10.
- New process challenges have been quickly addressed.
- Semiconductor supply chain is looking to DRIE for the emerging 3D semiconductor applications
- Microsystems should take benefits from those new applications

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