Quiz - Questions

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Generalities

Q1.1: Provide the name of 4 families of MEMS devices

Q1.2: True or False: A MEMS is not always a Microsystem, but a Microsystem is always a MEMS

Q1.3: List 5 advantages of using MEMS technology

Q1.4: Place these MEMS devices in their chronological order of commercialisation, oldest to most recent

- Digital light projector
- Inkjet print head
- Finger print sensor
- Microphone
- Accelerometer

Q1.5: What is the largest diameter (in mm) for a silicon wafer ?

Are MEMS mainly produced using this size of wafer (Yes/No)?

Q1.6: What are the two main techniques to micromachine silicon wafers to release mechanical microfabricated silicon structures (membranes, beams, comb drives…)

Q1.7: Which etch-stop technique to control the thickness of silicon membranes during silicon micromaching in KOH has been invented in Neuchâtel ?

Q1.8: I am Franz Lämmer, inventor at Bosch of a process used to etch silicon, named also the Bosch process. What is the technical name of this process ?

Q1.9: Is increasing or decreasing at lower scale:

- The surface to volume ratio ?

- The resonance frequency ?

Q1.10: What is this «MEMS» ?

MEMS Players

Q2.1: Who is the largest MEMS producer in revenue ?

Which product do they produce for which market ?

Q2.2: Name 3 MEMS producers in Switzerland ?

Q2.3: Name the top 2 major MEMS European producers

Q2.4: Name a major MEMS producer in Taiwan ?

Q2.5: Who is the leader in the optical MEMS field ?

Q2.6: What product is producing Knowles ?

Q2.7: Name three «MEMS» devices produced by Sensirion

Q2.8: What is the specificity of Sensirion in comparison to other MEMS company ?

Q2.9: What is the transducing principle of Colybris MEMS accelerometers ?

Q2.10: Tilting MEMS at SAFRAN-Colibrys operating at 175°C, provide the application ?

Q2.11: In the next 5 years, which market segment will represent 50% of the total MEMS market value ?

Q2.12: What is this MEMS ?

Transducers and MEMS Sensors

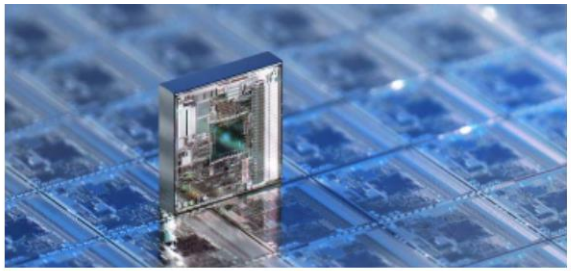
Q3.1: Name 3 types of MEMS devices using comb drives

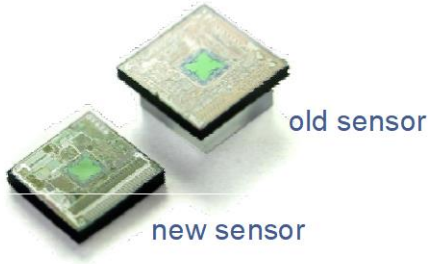
Q3.2: What is the transducing principle used for accelerometers in airbags ?

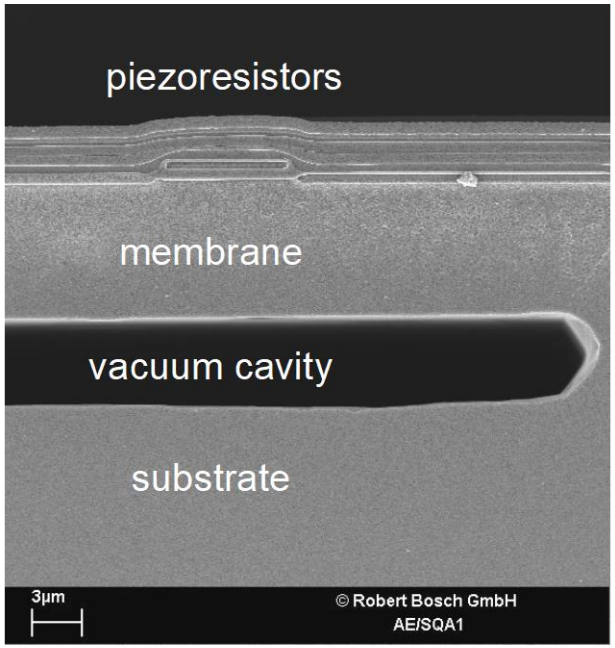
Q3.3: Provide the formulae relating $\Delta R/R$ of a narrow and long piezoresistor with the stresses on the membrane of a pressure sensor

Q3.4: How can you play with the dimensions of the membrane to increase the sensitivity of a pressure sensor ? Which one would you favor and why ?

Q3.5: Bosch has developped a pressure sensor on silicon integrating a sealed cavity. What is the specific material used in their process ?







Automotive Electronics

BOSCH

Q3.6: Name the main transducing principle used in MEMS microphone and the one that is now emerging

Q3.7: Draw the cross-section of a microphone

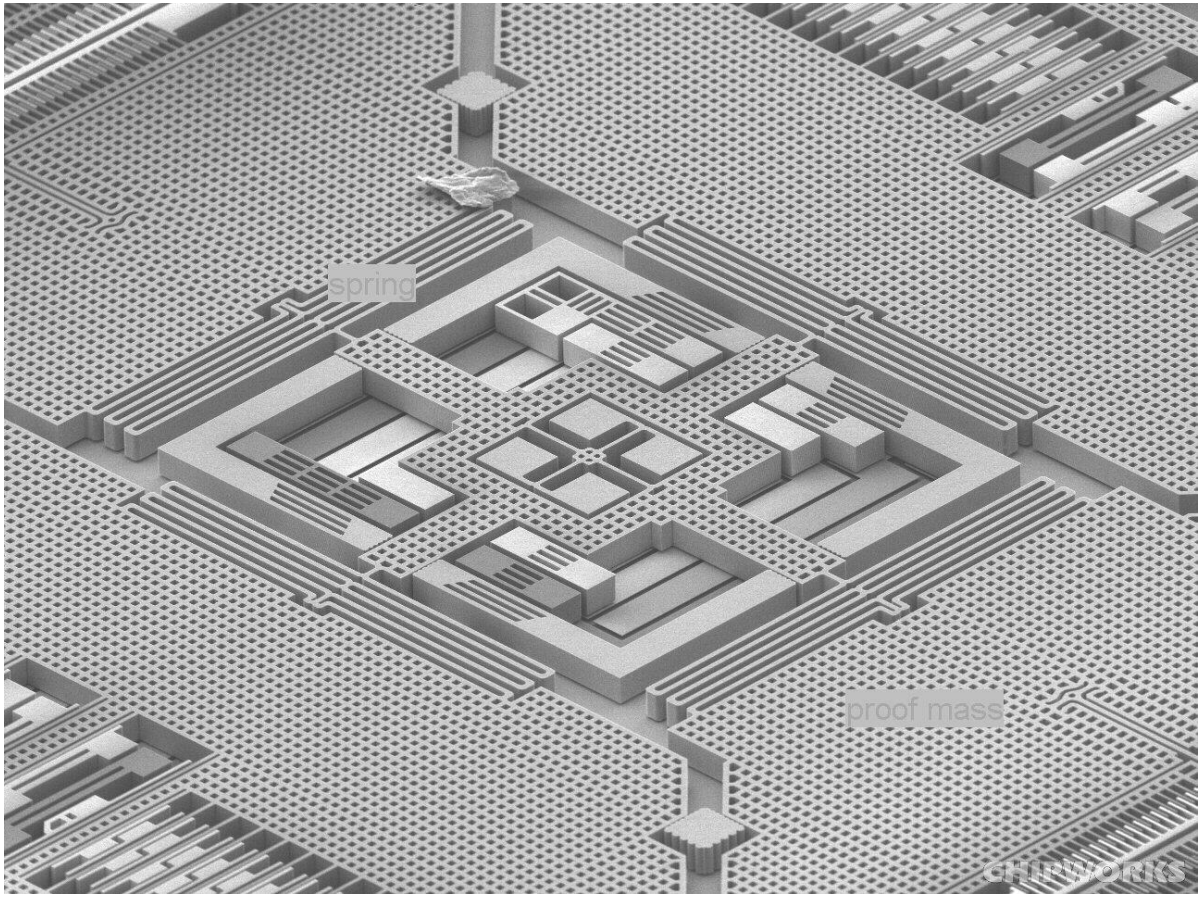
Q3.8: Which force is involved in the operating principle of a MEMS gyroscope ?

Q3.9: What are the 9 axis that can be found in a Inertial Measurement Unit (IMU) ?

Q3.10: How do we call the fact of combining different sensors to extrat specific information ?

Q3.11: What does mean ASIC ?

Q3.12: What is this MEMS ?



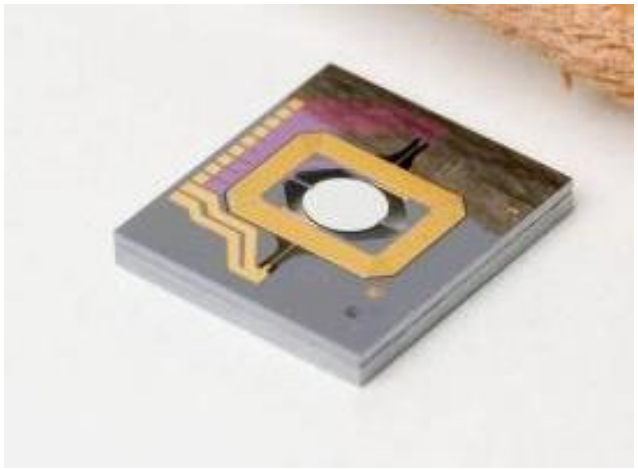
Optical MEMS

Q4.1: Name 3 MOEMS applications and their associated domains in the optical spectrum

Q4.2: Name the 2 main actuating principles used in Optical MEMS.

List one advantage and one drawback for each of them

Q4.3: What is this device used for ? And what is the actuation principle implemented ?



Q4.4: What is a LIDAR, what does it mean, what is the working principle, for which application ?

Q4.5: Draw the top view of a 2 x 2 Optical switch

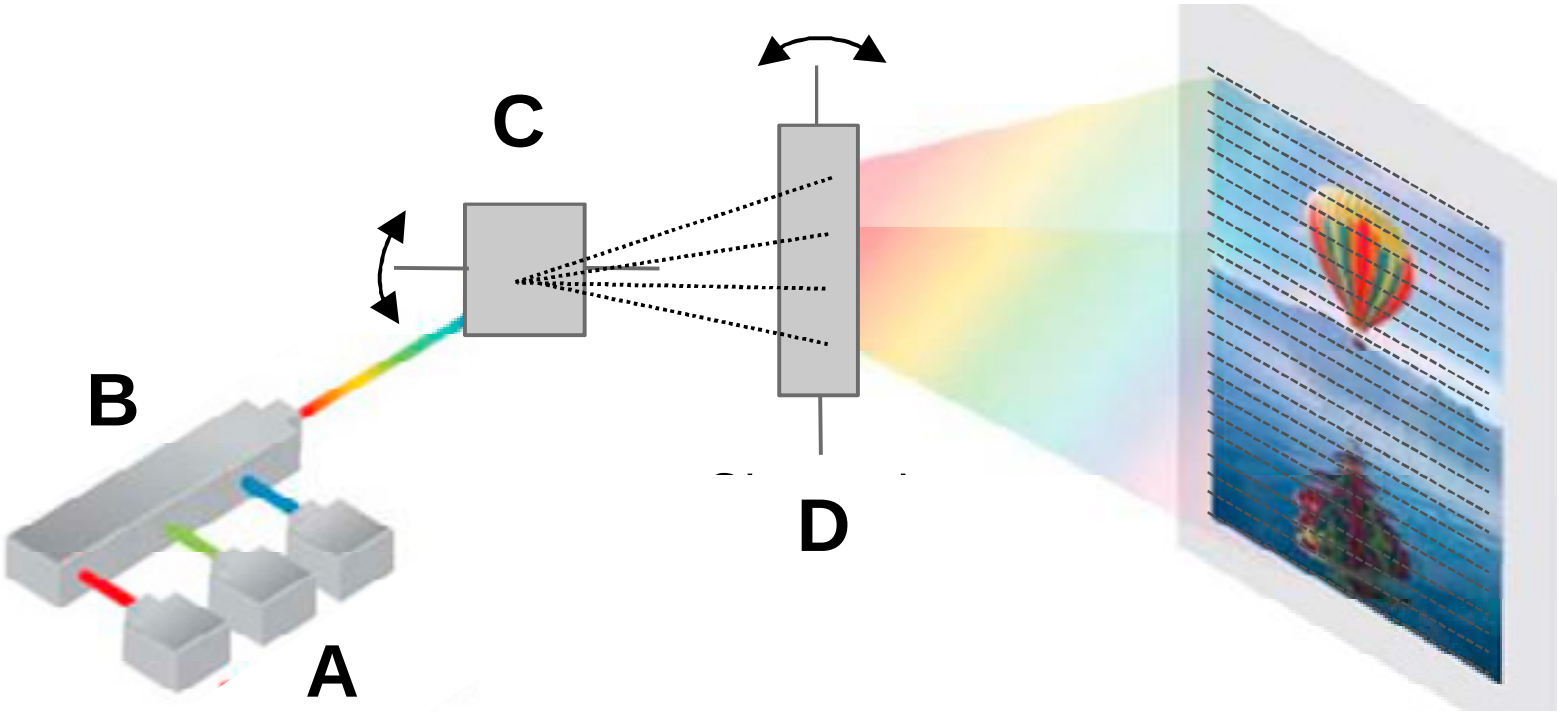
Q4.6: Complete with the name of the components missing

A=

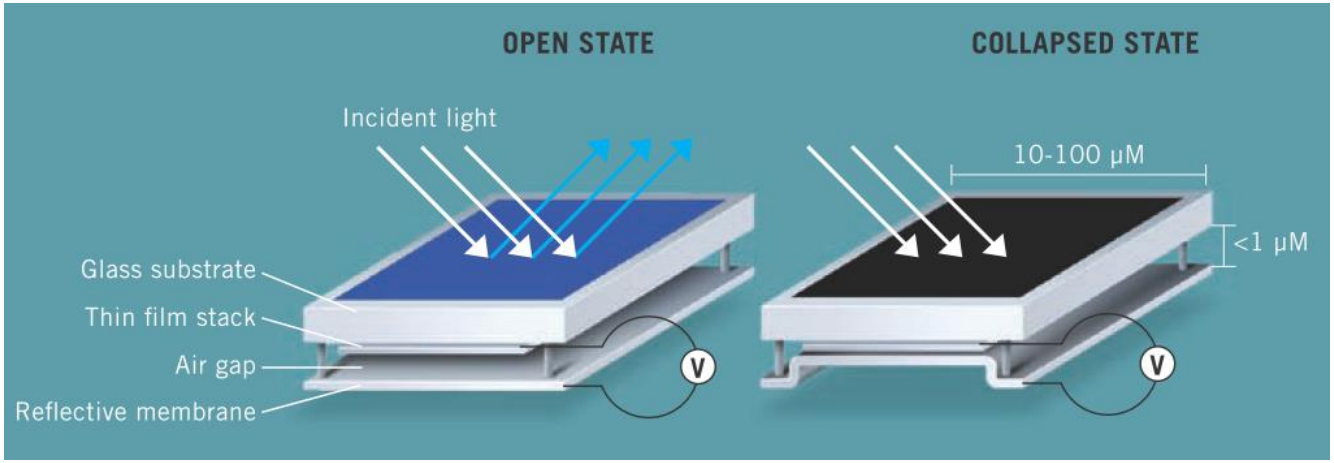
B=

C=

D=

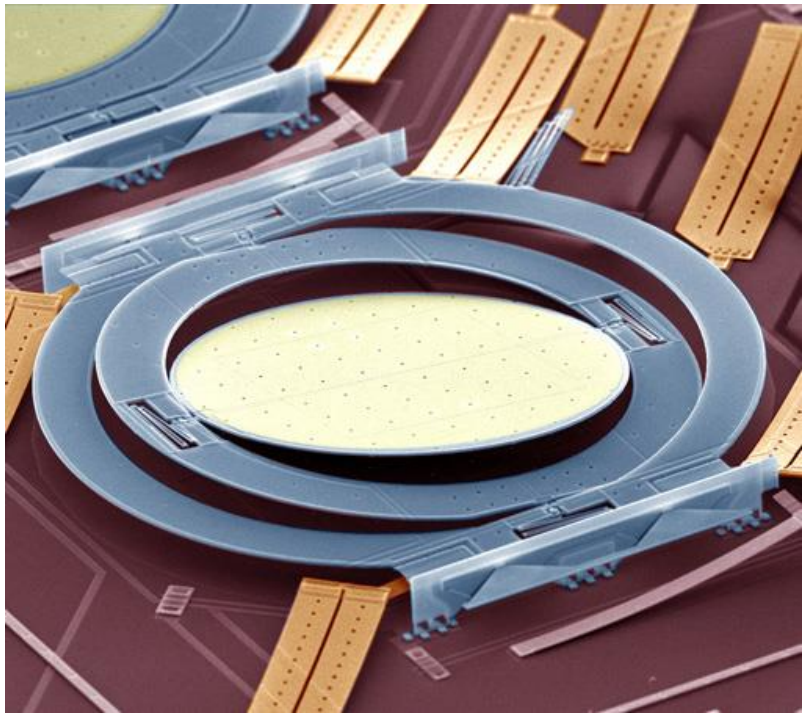


Q4.7: For what is used this Optical MEMS ?



Q4.8: For what is used this Optical MEMS ?

substrate lift arms mirror Frame, hinges, locks



Gas sensors, PowerMEMS and Packaging

Q5.1: In a micro-hotplate structure, list two:

A. Materials used to make the membrane
B. Materials used to make the heater
C. Failure modes

Q5.2: Name 3 types of sensing devices using heat in their sensing principle.

Q5.3: What is the difference between a thermal conductivity and a catalytic gas sensor ?

Q5.4: Draw the Id-Vg curve for a gas sensitive field-effect transistor (GasFET) without and in presence of hydrogen.

Q5.5: Name the 3 converting principle used to harvest energy from mechanical vibrations.

Rank them from highest to lowest power density at the micro-scale.

Q5.6: For vibrations energy harvester, list 4 parameters influencing the amount of power harvested.

Q5.7: Name 3 materials properties important to optimize the performance of thermoelectric generators.

Q5.8: Which material is mainly used for thermoelectric generator working from ambient to ~ 100°C

Name two techniques used to deposit it.

Q5.9: Name 4 bonding techniques suitable for hermetic packaging.

Q5.10: What is the typical range of working pressure for 1- accelerometer / 2- gyroscope

Q5.11: What is the different between 2.5D and 3D integration ?

Q5.12: Name 3 methods/materials used to make TSVs.