

Primo Appello Cocuzza 2

1. A piezo resistive structure can measure:
 - a. Average deflection
 - b. Force
 - c. Stress
 - d. Variation of potential
2. What is the effect of the center boss in a membrane based sensor?
 - a. Increase linearity
 - b. Decrease external noise
 - c. Increase robustness of sensor
 - d. Decrease temperature dependance
3. In Wheastone Bridge configuration for a pressure sensor, the piezo resistors on the membrane are placed...
 - a. Close to edge of the membrane exploiting compressive and tensile stress
 - b. Close to centre of the membrane exploiting compressive and tensile stress
 - c. A couple close to the centre a couple close to the edge exploiting longitudinal and transvers piezo properties.
 - d. Close to centre of the membrane exploiting longitudinal and transvers piezo properties.
4. About capacitive pressure sensors, the following are True or False?
 - a. The output is linear with respect to deflection **F**
 - b. The reduce the effect of temperature variation with respect to piezo resistive one **V**
 - c. They have an increased sensitivity with respect to piezo resistive one **V**
 - d. They measure the stress of a membrane **F**
5. About closed loop approach in micro sensors, the following are True or False?
 - a. They allows very sensitive structure of the expenses of the dynamic range **F**
 - b. The structure of the sensing element can be the same of the open loop approach **V**
 - c. The final solution is less expensive **F**
 - d. The electronic feedback is dominant with respect to the mechanical characteristics of the micro structure. **V**
6. In a dew point sensor based on a SAW device:
 - a. In Saw device temperature is decreased until the formation of dew.
 - b. In Saw device temperature is kept constant
 - c. In Saw device temperature is increased until the formation of dew.
 - d. No need of Temperature control.
7. About the impedance loaded on SAW for wireless micro sensor, the following are True or False?
 - a. Saw is used as 1 port component **F**
 - b. By tuning the load impedance the magnitude and phase of reflector can be adjusted **V**
 - c. The saw device is just a transponder not a sensor **V**
 - d. A different setup is useful to minimize common mode effect. **V**
8. Fluidic pumping can be implemented with acoustic micro structure with:
 - a. APM and SAW
 - b. SAW and TSM
 - c. FPM and SAW
 - d. APM and FPM
9. In a MEMS flow sensor the suspended micro structures are typically made of Si₃N₄ for:
 - a. Lower power consumption at a constant time
 - b. Lower power consumption at price of a higher time constant
 - c. Improved mechanical properties
 - d. Improved environmental endurance

APM: ACOUSTIC PLATE MODE
 SAW: SURFACE ACOUSTIC WAVE
 FPM: FLEXURAL PLATE MODE
 TSM: thickness shear mode

10. Mixing in micro fluidic is based on:
- Electro-osmotic effect
 - Diffusion
 - Turbulence
 - Diffusion + turbulence
11. A point of care is:
- A device for clinical test outside a standard lab for clinical analysis
 - A miniaturized sensor
 - A device for test inside a standard lab to minimize the cost
 - A device for test inside a standard lab to improve the sensitivity
12. In reciprocating micro pumps we usually need:
- 1 actuator
 - 1 actuator and 2 upstream and downstream passive valves
 - 3 actuator
 - 3 actuator and 3 upstream and downstream passive valves
13. What is the operating principle of fixed micro valves?
- They are based on integrated actuator
 - They Operate by a difference of pressure
 - They are based on fluidic resistance in 2 directions
 - They operate by a difference of temperature.
14. About the electro osmotic pumping
- The surface of the channel must be electrically charge free
 - the surface of the channel must be conductive
 - the surface of the channel must have trapped electric charges
 - ions have to be injected from the surface of the channel
15. A thermal bio sensor is characterized by:
- high sensitivity
 - High sensitivity and wide range of linear response
 - Low sensitivity and wide range of linear response
 - Low sensitivity and low range of linear response

DOMANDE

- Which are the advantage of micro hot plate technology with respect to thick film one for the case of Me-Ox semiconductive gas sensor?
- Why there is a clear trend in using polymers instead of Si or glass in micro fluidic device for BIO application?
- What is off-axis illumination? How it works? Which are its main limitations?
- Why EUV mask is illuminated with 6° angle off the normal optical axes? Which are the consequences? What happens with an angle of 9° ?
- Given a lithographic system based on ArF laser and $NA=0.7$ with a process able to guarantee a $k_1=0.25$ is it possible to expose feature with $CD=40$ nm? What would you suggest to improve the resolution without changing the system?
- If we want to control the phase shifting mask $n=1.56$ for ArF with $\theta=2$ deg, show that the thickness of the phase shifting material must be controlled ≈ 1.9 nm
- Given a minimal acceptable NILS of 2.5 what is the minimum spinning speed for the resist in the reported characteristic to tolerate the resulting DOF?

ADVANCED TECHNOLOGIES AND APPLICATIONS

Exam Questions examples

1. When applying a center-boss in a membrane-based sensor, to improve linearity a trade-off is needed between ... **(0.2 pts)**
 - a. Position of the boss on the membrane
 - b. Material of the boss and the suspending beams
 - c. Thickness and width of the boss
 - d. Width of the boss with respect to the width of the membrane (solidity ratio)
2. The Force Balance approach for capacitive accelerometers is applied to ... **(0.2 pts)**
 - a. Improve the trade-off between sensitivity and linearity range
 - b. Improve the trade-off between accuracy and linearity range
 - c. Improve the trade-off between sensitivity and robustness
 - d. Improve the trade-off between cost and performance
3. In a dew point sensor based on a SAW device: **(0.2 pts)**
 - a. The SAW device temperature is decreased until formation of dew
 - b. The SAW device temperature is kept constant
 - c. The SAW device temperature is increased until formation of dew
 - d. No temperature control is necessary for the SAW device
4. Concerning the power for a Surface Acoustic Waves (SAW) based sensor ... **(0.2 pts)**:
 - a. It is wireless transmitted from an external transmitter
 - b. It is provided by a local battery
 - c. It does need no power since it behaves like a variable echo
 - d. It is provided by a local energy harvesting system
5. About the SAW structure for a microsensor, indicate which of the following sentences are True or False: **(0.4 pts)**
 - a. They are poorly suited for liquid sensing ✓
 - b. They can be made suited for liquid sensing if a Shear Horizontal wave is generated ✓
 - c. They cannot be bonded to a substrate ✗
 - d. They are generally more sensitive than APM structures ✓
6. What is the operating principle of fixed microvalves ? **(0.2 pts)**
 - a. They are based on an integrated actuator
 - b. They are operated by a pressure difference
 - c. They are based on different fluidic resistances in the two directions
 - d. They are operated by a temperature difference
7. An Ion Sensitive FET (ISFET) measures: **(0.2 pts)**
 - a. The variation of enthalpy in an induced chemical reaction
 - b. The generation of light in an induced chemical reaction
 - c. The variation of pH in an induced chemical reaction
 - d. The specifically adsorbed mass of a target element
8. For projection printing, which option(s) can give improved resolution **(0.4 pts)** ?
 - a. Thinner photoresist
 - b. Usage of phase-shifting mask
 - c. Shorter wavelength
 - d. Smaller numerical aperture
9. The refraction index of a phase shift material (PSM) is 1.51 at a wavelength of 248 nm, and 1.56 at a wavelength of 193 nm. For KrF and ArF lithography, the thickness of the PSM in order to achieve 180-

$$n = 1,51 \quad @ \quad \lambda = 248 \text{ nm}$$

$$n = 1,56 \quad @ \quad \lambda = 193 \text{ nm}$$

- deg phase shifting is **(0,2 pts)**:
- 486 nm and 345 nm, respectively
 - 243 nm and 172 nm, respectively
 - 82 nm and 62 nm, respectively
 - 63 nm and 54 nm, respectively
10. EUV lithography requires reflective optics because of **(0,2 pts)**:
- low refractive index of materials @13,5 nm
 - high refractive index of materials @13,5 nm
 - low absorbance index of materials @13,5 nm
 - high absorbance of materials @13,5 nm
11. The laser Fluence is:
- The optical power/unit area and can be used for both pulsed and CW lasers
 - The pulse energy/unit area and can be used only for pulsed lasers
 - The pulse energy/unit area and can be used for both pulsed and CW lasers
 - The optical power/unit area and can be used for CW lasers
12. Select two types of solid-state lasers:
- CO2 laser, diode-pumped laser
 - Lamp-pumped laser, diode-pumped laser
 - Distributed Bragg reflector, Distributed feedback
 - HeNe laser, VCSEL
13. Describe the Time of Flight technique for a flow sensor, and advantages and disadvantages with respect to the anemometric one (no lines limit, drawings allowed) **(1 pts)**
14. Why there is a clear trend in using polymers instead of silicon or glass in microfluidic devices for biological applications ? (10 lines maximum or a table, no drawing allowed) **(0.8 pts)**
15. Describe how a SAW sensor may be wirelessly interrogated **(2 pts)**
16. Which are the main requirements for a lithographic process to be fruitfully employed in IC manufacturing **(2 pts)** ?
17. Define coherent, incoherent, and partially coherent illumination **(1 pts)**
18. Describe and compare Stepper and Scanner exposure systems **(2 pts)**
19. Describe and compare the 3 double-patterning techniques **(2 pts)** ?
20. If we want to control the phase shift on a phase-shifting mask ($n = 1,56$) for ArF lithography to ± 2 deg, show that the thickness of the phase-shifting material must be controlled to ± 1.9 nm

1. About the impedance loaded SAW, which of the following are true or false?
 - a. SAW is used as 1 port component **F**
 - b. By tuning the load impedance the magnitude of reflector can be adjusted **T**
 - c. The SAW structure is the sensing part **F**
 - d. A differential setup is too complicated to be implemented **F**
2. About Magneto Hydro Dynamic (MHD):
 - a. It requires a conductive fluid
 - b. It requires a dielectric substrate
 - c. It requires a dielectric fluid
 - d. It is independent from fluid and substrate
3. What is the working principle of a passive micro valve?
 - a. They are based on integrated actuator
 - b. They are operated by pressure difference
 - c. They are based on peristaltic movement
 - d. They are based on different fluidic resistance in the two directions
4. About the actuation frequency for some micro fluidic actuators which of the following is true or false?
 - a. Electrostatic actuation is faster than shape memory alloy based one **T**
 - b. Bubble actuation is faster than electrostatic
 - c. Bimetallic actuation is faster than EM **F**
 - d. Electrostatic actuation is faster than thermopneumatic **T**
5. In a reciprocating micropump often two parallel devices are used to:
 - a. Create a bidirectional pumping mechanism
 - b. Minimize the ripple in output
 - c. Have a second working device in case of failure
 - d. Increase the maximum output sense.
6. The refraction index of a phase shifting material (PSM) is 1.51 at 248 nm and 1.56 at 193 nm. For KrF and ArF lithography the thickness of the PSM is order to achieve 180° phase shifting is
 - a. 486 nm and 345 nm respectively
 - b. 243 nm and 172 nm respectively
 - c. 82 nm and 172 nm respectively
 - d. 83 nm and 54 nm respectively
7. EUV lithography requires reflective optics because of:
 - a. Low refractive index at 13.5 nm
 - b. High refractive index at 13.5 nm
 - c. low absorbance at 13.5 nm
 - d. High absorbance at 13.5 nm
8. Which kind of laser should be used to minimize the thermal effect during a drilling process
 - a. CW laser (CW=continuous wave laser)
 - b. Ns laser
 - c. Ps laser
 - d. Fs laser
9. True or false, which options can give improved resolution

- a. Thinner Photoresist \uparrow
- b. Usage of phase-shifting mask \uparrow
- c. Shorter wavelength \uparrow
- d. Smaller NA \downarrow
- e.

- 10. Which are the physical effect of scaling down in microfluidics? (1pt)
- 11. Explain the working principle of electroosmotic pumping (no lines limit drawing allowed) (1.5 pt)
- 12. Explain the working principle of a FET for H sensing. (1pt)
- 13. Explain the working mechanism of a chemically amplified resist (1.5 pt)
- 14. Which metric best characterise the quality of an aerial image and why? (1pt)
- 15. What is the a pellicle for a lithographic reticle? (1pt)

ADVANCED TECHNOLOGIES AND APPLICATIONS

Exam Questions examples

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 - a. Position of the boss on the membrane
 - b. Material of the boss and the suspending beams
 - c. Thickness and width of the boss
 - d. Width of the boss with respect to the width of the membrane (solidity ratio)
2. The Force Balance approach for capacitive accelerometers is applied to ... **(0.2 pts)**
 - a. Improve the trade-off between sensitivity and linearity range
 - b. Improve the trade-off between accuracy and linearity range
 - c. Improve the trade-off between sensitivity and robustness
 - d. Improve the trade-off between cost and performance
3. In a dew point sensor based on a SAW device: **(0.2 pts)**
 - a. The SAW device temperature is decreased until formation of dew
 - b. The SAW device temperature is kept constant
 - c. The SAW device temperature is increased until formation of dew
 - d. No temperature control is necessary for the SAW device
4. Concerning the power for a Surface Acoustic Waves (SAW) based sensor ... **(0.2 pts)**:
 - a. It is wireless transmitted from an external transmitter
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 - c. It does need no power since it behaves like a variable echo
 - d. It is provided by a local energy harvesting system
5. About the SAW structure for a microsensors, indicate which of the following sentences are True or False: **(0.4 pts)**
 - a. They are poorly suited for liquid sensing \top
 - b. They can be made suited for liquid sensing if a Shear Horizontal wave is generated \top
 - c. They cannot be bonded to a substrate \top
 - d. They are generally more sensitive than APM structures \top
6. What is the operating principle of fixed microvalves ? **(0.2 pts)**
 - a. They are based on an integrated actuator
 - b. They are operated by a pressure difference
 - c. They are based on different fluidic resistances in the two directions
 - d. They are operated by a temperature difference
7. An Ion Sensitive FET (ISFET) measures: **(0.2 pts)**
 - a. The variation of enthalpy in an induced chemical reaction
 - b. The generation of light in an induced chemical reaction
 - c. The variation of pH in an induced chemical reaction
 - d. The specifically adsorbed mass of a target element
8. For projection printing, which option(s) can give improved resolution **(0.4 pts)** ?
 - a. Thinner photoresist
 - b. Usage of phase-shifting mask
 - c. Shorter wavelength
 - d. Smaller numerical aperture
9. The refraction index of a phase shift material (PSM) is 1.51 at a wavelength of 248 nm, and 1.56 at a wavelength of 193 nm. For KrF and ArF lithography, the thickness of the PSM in order to achieve 180-deg phase shifting is **(0,2 pts)**:
 - a. 486 nm and 345 nm, respectively
 - b. 243 nm and 172 nm, respectively
 - c. 82 nm and 62 nm, respectively

- d. 63 nm and 54 nm, respectively
10. EUV lithography requires reflective optics because of **(0,2 pts)**:
- low refractive index of materials @13,5 nm
 - high refractive index of materials @13,5 nm
 - low absorbance index of materials @13,5 nm
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11. The laser Fluence is:
- The optical power/unit area and can be used for both pulsed and CW lasers
 - The pulse energy/unit area and can be used only for pulsed lasers
 - The pulse energy/unit area and can be used for both pulsed and CW lasers
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12. Select two types of solid-state lasers:
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18. Describe and compare Stepper and Scanner exposure systems **(2 pts)**
19. Describe and compare the 3 double-patterning techniques **(2 pts)** ?
20. If we want to control the phase shift on a phase-shifting mask ($n = 1,56$) for ArF lithography to ± 2 deg, show that the thickness of the phase-shifting material must be controlled to ± 1.9 nm

exam (1)

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exam (1)

ADVANCED TECHNOLOGIES AND APPLICATIONS

Exam Questions examples

- Pressure sensors
slide 15
1. When applying a center-boss in a membrane-based sensor, to improve linearity a trade-off is needed between ... **(0.2 pts)**
- Position of the boss on the membrane
 - Material of the boss and the suspending beams
 - Thickness and width of the boss
 - ~~Width of the boss with respect to the width of the membrane (solidity ratio)~~
- Accelerometers
slide 14
2. The Force Balance approach for capacitive accelerometers is applied to ... **(0.2 pts)**
- ~~Improve the trade-off between sensitivity and linearity range~~
 - Improve the trade-off between accuracy and linearity range
 - Improve the trade-off between sensitivity and robustness
 - Improve the trade-off between cost and performance
- Acoustic sensors
slide 22
3. In a dew point sensor based on a SAW device: **(0.2 pts)**
- ~~The SAW device temperature is decreased until formation of dew~~
 - The SAW device temperature is kept constant
 - The SAW device temperature is increased until formation of dew
 - No temperature control is necessary for the SAW device
- Acoustic sensors
slide 27
4. Concerning the power for a Surface Acoustic Waves (SAW) based sensor ... **(0.2 pts)**:
- ~~It is wireless transmitted from an external transmitter~~
 - It is provided by a local battery
 - It does need no power since it behaves like a variable echo
 - It is provided by a local energy harvesting system
- Acoustic sensors
5. About the SAW structure for a microsensor, indicate which of the following sentences are True or False: **(0.4 pts)**
- T** a. They are poorly suited for liquid sensing *slide 8*
 - T** b. They can be made suited for liquid sensing if a Shear Horizontal wave is generated *slide 9*
 - F** c. They cannot be bonded to a substrate *slide 9*
 - T** d. They are generally more sensitive than APM structures *slide 9*
- μ fluidic
slide 20
6. What is the operating principle of fixed microvalves ? **(0.2 pts)**
- They are based on an integrated actuator

- They are operated by a pressure difference
- ~~They are based on different fluidic resistances in the two directions~~

- Flow sensors
slide 16
7. An Ion Sensitive FET (ISFET) measures: **(0.2 pts)**
- The variation of enthalpy in an induced chemical reaction
 - The generation of light in an induced chemical reaction
 - ~~The variation of pH in an induced chemical reaction~~
 - The specifically adsorbed mass of a target element

- Advanced litho
slide 63
- $R = K_i \frac{\lambda}{NA}$
8. For projection printing, which option(s) can give improved resolution **(0.4 pts)** ?
- ~~Thinner photoresist *from PTP ?*~~
 - ~~Usage of phase-shifting mask~~
 - ~~Shorter wavelength~~
 - Smaller numerical aperture *should actually be bigger*

- Advanced litho
slide 101
9. The refraction index of a phase shift material (PSM) is 1.51 at a wavelength of 248 nm, and 1.56 at a wavelength of 193 nm. For KrF and ArF lithography, the thickness of the PSM in order to achieve 180-deg phase shifting is **(0.2 pts)**:

- 486 nm and 345 nm, respectively
 - ~~243 nm and 172 nm, respectively~~
 - 82 nm and 62 nm, respectively
- $KrF: d = \frac{126}{0.51} = 243 \text{ nm}$
- $ArF: d = \frac{96.5}{1.56} = 62 \text{ nm}$

Primo Appello Cocuzza 2

08/07/24 23:32



Primo Appello...

Primo Appello Cocuzza 2

Pressure sensors
slide 2

1. A piezo resistive structure can measure:
- Average deflection
 - Force
 - ~~Stress~~
 - Variation of potential

Pressure sensors
slide 15

2. What is the effect of the center boss in a membrane based sensor?
- ~~Increase linearity~~
 - Decrease external noise
 - Increase robustness of sensor
 - Decrease temperature dependence

Pressure sensors
slide 3

3. In Wheatstone Bridge configuration for a pressure sensor, the piezo resistors on the membrane are placed...
- ~~Close to edge of the membrane exploiting compressive and tensile stress~~
 - Close to centre of the membrane exploiting compressive and tensile stress
 - A couple close to the centre a couple close to the edge exploiting longitudinal and transvers piezo properties.
 - Close to centre of the membrane exploiting longitudinal and transvers piezo properties.

Pressure sensors
slide 2

4. About capacitive pressure sensors, the following are True or False?

- ~~F~~ a. The output is linear with respect to deflection *slide 13*
- ~~T~~ b. The reduce the effect of temperature variation with respect to piezo resistive one
- ~~T~~ c. They have an increased sensitivity with respect to piezo resistive one
- ~~F~~ d. They measure the stress of a membrane *they measure an average deflection*

Accelerometers

5. About closed loop approach in micro sensors, the following are True or False?

- ~~F~~ a. They allows very sensitive structure of the expenses of the dynamic range *slide 14*
- ~~T~~ b. The structure of the sensing element can be the same of the open loop approach *slide 15*
- ~~F~~ c. The final solution is less expensive *slide 16*
- ~~T~~ d. The electronic feedback is dominant with respect to the mechanical characteristics of the micro structure. *slide 16*

Acoustic sensors
slide 22

6. In a dew point sensor based on a SAW device:
- ~~X~~ In Saw device temperature is decreased until the formation of dew.

b. In Saw device temperature is kept constant

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