



قائمة الاسئلة

الأنظمة الكهروميكانيكية الدقيقة - قسم الهندسة الطبية الحيوية - المستوى الرابع - درجة هذا الاختبار (50)

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- 1) In order to obtain a high deposition rate for the material, the vapor pressure of the source material must be _____ the background vacuum pressure.
 - 1) ☒ Above
 - 2) ☐ Below
 - 3) ☐ Equal
 - 4) ☐ All of answers are correct
- 2) In the case of microgripper with a comb-drive actuator, a drastic _____ in required actuation voltage with _____ of number of pairs of electrodes.
 - 1) ☐ Increase, increase
 - 2) ☐ Reduction, reduction
 - 3) ☒ Reduction, increase
 - 4) ☐ All of answers are incorrect
- 3) Thermopiles are multiple thermocouples that are arranged in _____ with voltage output in _____.
 - 1) ☒ Parallel, series
 - 2) ☐ Series, parallel
 - 3) ☐ Series, series
 - 4) ☐ Parallel, parallel
- 4) Most of the micro accelerometer are built on the principle of _____.
 - 1) ☐ Electrostatic force
 - 2) ☐ Electromagnetic force
 - 3) ☐ Thermal force
 - 4) ☒ Mechanical deformation
- 5) "Cannot maintain the actuated movement for sustained period of time due to overheating" this is a major disadvantages of _____ actuation techniques
 - 1) ☐ Thermal force
 - 2) ☐ Shape-memory alloys
 - 3) ☒ Piezoelectric
 - 4) ☐ Electrostatic force
- 6) The photoresist that after exposure to light dissolve in development is the _____ type.
 - 1) ☒ Positive
 - 2) ☐ Negative
 - 3) ☐ Either positive or negative
 - 4) ☐ All of answers are incorrect
- 7) Wet oxidation of silicon is often preferred because of _____.
 - 1) ☐ Lower cost
 - 2) ☐ Better quality of SiO₂
 - 3) ☒ Faster oxidation
 - 4) ☐ All of answers are correct
- 8) The higher the class number of the clean room is the cleaner room.
 - 1) ☐ True .
 - 2) ☒ False .
- 9) Diffusion process is an example of _____.
 - 1) ☐ Pressure driving flow
 - 2) ☒ Entropy-driven transport
 - 3) ☐ Gradient induced flow



- 4) - All of answers are incorrect
- 10) Diffusion that occurs when the doping concentration is lower than the intrinsic carrier concentration is called intrinsic diffusion.
- 1) ☒ True .
- 2) - False .
- 11) In the case of _____, an additional filament in the chamber is used to increase the sputter rate by producing additional electrons.
- 1) - Reactive sputtering
- 2) ☒ Triode sputtering
- 3) - Magnetron sputtering
- 4) - All of answers are incorrect
- 12) _____ is (are) not a property of sputtering thin films.
- 1) - Dense films
- 2) - Smaller grain size
- 3) - Good adhesion
- 4) ☒ Directionality
- 13) Laminar flow of compressible fluid normally takes place with Reynold number in the range of _____.
- 1) - 0-10
- 2) ☒ 10-100
- 3) - 100-1000
- 4) - >1000
- 14) The angle between the orientation $\langle 100 \rangle$ to the (111) plane in a single silicon crystal cell is _____ degree.
- 1) ☒ 54.74
- 2) - 30
- 3) - 67.2
- 4) - 75
- 15)

Use the geometry and the dimensions of the inkjet printer head as presented in next Figure. For a printing resolution of 600 dots per inch (DPI), and the ink droplet is assumed to produce a dot with a film thickness of $1 \mu\text{m}$ on the paper. Assume that the ink droplet takes the shape of a sphere and the inkwell is always refilled after ejection. Determine the electric voltage required to eject a droplet of ink from an inkjet printer head with a PZT piezoelectric crystal as a pumping mechanism. $V = \text{_____}$

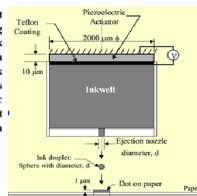


Table 7.14 | Piezoelectric coefficients of selected materials

Piezoelectric crystals	Coefficient d , 10^{-12} m/V	Electromechanical conversion factor K
Quartz (crystal SiO_2)	2.3	0.1
Srrium titanate (BaTiO_3)	100-190	0.49
Lead zirconate titanate, PZT ($\text{PbTi}_{1-x}\text{Zr}_x\text{O}_3$)	480	0.72
PbZrO_3	250	
PbTiO_3	80	
PbNbO_3	350	0.78
Scandate salt ($\text{NaKC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$)	18	
Polyvinylidene fluoride, PVDF		

Source: Kinsap [1997], Askeland [1994].

- 1) - 0.7435 v
- 2) ☒ 0.9342 v
- 3) - 1.5052 v
- 4) - All of answers are incorrect
- 16) In general, phenomena that is weakly depends on size dominate in small dimensions is (are) _____.
- 1) - Friction
- 2) - Surface tension
- 3) - Diffusion
- 4) ☒ All of answers are correct
- 17) Extrinsic semiconductors are obtained from the intrinsic semiconductors by the process of _____.



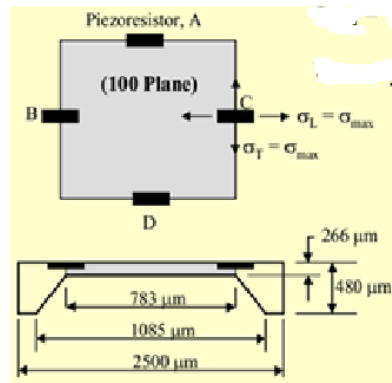
- 1) ☒ Doping
- 2) ☐ Oxidation
- 3) ☐ Electroplating
- 4) ☐ Etching

- 18) Estimate the change of resistance in a silicon piezo-resistance attached to the diaphragm of a pressure sensor as shown in the next Figure. If the Typical values of stress, and piezo-resistance coefficients:

$$\sigma_I = \sigma_T = \sigma_{max} = 186.8 \text{ MPa},$$

$$\pi_L = \pi_T = 0.02\pi_{44} \text{ \& } \pi_{44} = 138.1 \times 10^{-11} \text{ pa}^{-1}$$

The change of resistance in a silicon piezo-resistance is _____.



- 1) ☐ 1.21323
 - 2) ☐ 2.51211
 - 3) ☒ 0.01032
 - 4) ☐ All of answers are incorrect
- 19) The single-unit cell for quartz contains _____ at the apexes at the base and _____ at the other apex of the tetrahedron.
- 1) ☐ 2 oxygen atom, 3 silicon atoms
 - 2) ☐ 3 oxygen atoms, 2 silicon atoms
 - 3) ☐ 2 oxygen atoms, 2 silicon atoms
 - 4) ☒ 3 oxygen atoms, 1 silicon atom
- 20) A p-n junction refers to the location at which the implanted ion concentration _____ the existing background concentration of dopant in the wafer.
- 1) ☐ Larger than
 - 2) ☐ Smaller than
 - 3) ☒ Matches
 - 4) ☐ All of answers are incorrect
- 21) Electrophoresis is a common technique to separate macromolecules such as _____.
- 1) ☐ DNA
 - 2) ☐ RNA
 - 3) ☐ Proteins
 - 4) ☒ All of answers are correct
- 22) The ability of a photoresist to produce acceptably sharp images is known as _____.
- 1) ☐ Dose
 - 2) ☐ Resolution
 - 3) ☒ Contrast
 - 4) ☐ Line of site
- 23) Electrohydrodynamic mainly focused on the fluid _____ induced by electric fields.
- 1) ☐ Dissolution
 - 2) ☒ Motion
 - 3) ☐ Solidification
 - 4) ☐ All of answers are incorrect
- 24) The principal use of electrohydrodynamic in microsystems is to _____.
- 1) ☐ Conduct electrolysis of minute chemicals



- 2) ☒ + Move minute amounts of fluid
- 3) ☐ - Detect minute amounts of fluid
- 4) ☐ - All of answers are incorrect
- 25) Determine the pressure required overcoming the surface tension of water in small tube of 0.5 mm inside diameter. Assume that the water is at 50°C. $\Delta P =$ _____ Pa.
- 1) ☐ - 773
- 2) ☒ + 812
- 3) ☐ - 855
- 4) ☐ - 876
- 26) The high throughput capabilities of capillary electrophoresis (CE) are achieved through the possibility of _____.
- 1) ☐ - Reducing analysis time
- 2) ☐ - Lowering sample volume requirements
- 3) ☐ - Lowering solvent consumption
- 4) ☒ + Performing simultaneous separations in parallel channels
- 27) In ion implementation within an electric field, the _____ is used to separate charged from neutral particles.
- 1) ☒ + Deflection of beam
- 2) ☐ - Mass filter
- 3) ☐ - Energy filter
- 4) ☐ - Optics system
- 28) To make a polymer electrically conductive, which of the following method is (are) not used? _____.
- 1) ☐ - Pyrolysis
- 2) ☒ + Oxidation
- 3) ☐ - Doping
- 4) ☐ - Insertion of conductive polymers
- 29) The total number of atoms in a silicon unit crystal structure is _____.
- 1) ☐ - 12
- 2) ☐ - 14
- 3) ☐ - 16
- 4) ☒ + 18
- 30) The average distance a gas molecule travels before colliding with another gas molecule or the container walls is known as _____.
- 1) ☐ - Mean Free time
- 2) ☐ - Straggle
- 3) ☐ - Dose
- 4) ☒ + Mean Free Path
- 31) The effect of surface tension on fluid flowing in a capillary tube makes the volumetric flow _____ the same flow in mesosize tube.
- 1) ☐ - Much greater than
- 2) ☐ - About equal to
- 3) ☒ + Much less than
- 4) ☐ - All of answers are incorrect
- 32) The growth of silicon crystals is slowest in the _____ direction.
- 1) ☐ - $\langle 100 \rangle$
- 2) ☐ - $\langle 110 \rangle$
- 3) ☒ + $\langle 111 \rangle$
- 4) ☐ - All of answers are incorrect
- 33) The low-pressure chemical vapor deposition (LPCVD) process is carried out at _____.
- 1) ☐ - Ultra-High Vacuum



- 2) - High Vacuum
3) ☒ Rough Vacuum
4) - All of answers are correct
- 34) In Clean Room Class I, the number of 0.5 μm particles per ft² is _____.
- 1) ☒ 1
2) - 10
3) - 100
4) - 1000
- 35) A silicon substrate is doped with phosphor ions at 30 keV. Assume the maximum concentration after the doped is $30 \times 10^{18}/\text{cm}^3$. Hint: $R_p = 42 \times 10^{-9} \text{ m}$, and $\Delta R_p = 19.5 \times 10^{-9} \text{ m}$. The dose, Q is _____ atoms/cm².
- 1) ☒ 1.466×10^{14}
2) - 50.22×10^{12}
3) - 76.32×10^{10}
4) - All of answers are correct
- 36) The secondary flats are used to indicate the _____, whereas the primary flats are used to indicate the _____.
- 1) - Crystal orientation of the wafer structure, Dopant type of the wafer
2) ☒ Dopant type of the wafer, Crystal orientation of the wafer structure
3) - n-type, p-type
4) - All answers are incorrect
- 37) Laminar fluid flow means a _____.
- 1) - High inertial forces
2) - Low velocity
3) - High Re
4) ☒ High velocity
- 38) Electro-osmotic flow is a type of _____.
- 1) - Shear flow
2) ☒ Uniform flow
3) - Parabolic flow
4) - All of answers are incorrect
- 39) In general, a microsystem consists of _____ components.
- 1) - One
2) - Two
3) ☒ Three
4) - Four
- 40) Ion implementation is a technique to do _____:
- 1) - Deposit an insulation layer



- 2) ☒ Dope a semiconductor
- 3) ☐ Deposit a metallic layer
- 4) ☐ Deposit a metallic layer on an insulator
- 41) For the thermal evaporation process, collision is less likely when Knudsen numbers, Kn _____.
1) ☐ Equal to 1
2) ☐ <1
3) ☒ >1
4) ☐ All of answers are correct
- 42) Within Molecular Beam Epitaxy (MBE), it is not possible to have a thin, sharp, box-shaped distribution of dopants.
1) ☐ True .
2) ☒ False .
- 43) The line-of-sight nature of the evaporation deposition process leads to the issue of _____ for topographic features on a wafer.
1) ☐ Sputtering yield
2) ☒ Step coverage
3) ☐ Shadowing
4) ☐ All answers are correct
- 44) _____ is the amount of material incident on a surface per unit surface area per unit time.
1) ☐ Sputtering yield
2) ☐ Step coverage
3) ☐ Flux
4) ☒ Arrival rate
- 45) There are _____ piezoresistive coefficient in silicon piezoresistors.
1) ☒ Three
2) ☐ Four
3) ☐ Five
4) ☐ Six
- 46) The number of target atoms that are emitted per incident ion is called the _____.
1) ☐ Arrival rate
2) ☐ Mean free path
3) ☐ Step coverage
4) ☒ Sputtering yield
- 47) Which of the following PVD technique can deposit film with better purity?
1) ☒ E-beam evaporation
2) ☐ Sputtering
3) ☐ Thermal evaporation
4) ☐ Thermal oxidation
- 48) A hexamethyl disilazane (HMDS) is a(an) _____.
1) ☐ Negative resist
2) ☒ Adhesion promoter
3) ☐ Positive resist
4) ☐ All answers are correct
- 49) Epitaxy involves the growth of _____ films over a substrate made of the same material.
1) ☒ Single-crystal
2) ☐ Organic
3) ☐ Metallic
4) ☐ Inorganic
- 50) In LPCVD, at lower pressure, if mass transfer co-efficient is increased, the system operation switches to



the _____.

- 1) ☒ Surface reaction-controlled regime
 - 2) ☐ Mass transport limited regime
 - 3) ☐ Diffusion limited regime
 - 4) ☐ Lower rate of deposition
- 51) _____ micromachining is primarily a subtractive process, while _____ micromachining is an additive process, both of which are used to fabricate MEMS devices.
- 1) ☐ Granular, achondritic
 - 2) ☒ Bulk, surface
 - 3) ☐ Reduction, oxidation
 - 4) ☐ Integrated, discrete
- 52) Joining glass to silicon wafer can be done by _____.
- 1) ☐ Plasma Bonding
 - 2) ☒ Anodic Bonding
 - 3) ☐ Fusion bonding
 - 4) ☐ Eutectic Bonding
- 53) In PVD, the MFP is of a lower order of magnitude than the distance from the source to the substrate.
- 1) ☐ True .
 - 2) ☒ False .
- 54) Materials that exhibit electric polarization when exposed to intense electric field are known as _____.
- 1) ☐ Piezoelectric materials
 - 2) ☐ Ferromagnetic materials
 - 3) ☐ Electromagnetic materials
 - 4) ☒ Ferroelectric materials
- 55) A 10 times reduction in electrode linear dimensions will gives a 1000 times reduction in the magnitude of electrostatic forces.
- 1) ☐ True .
 - 2) ☒ False .
- 56) Change in output of any sensor with respect to change in input is expressed as _____.
- 1) ☐ Accuracy
 - 2) ☒ Sensitivity
 - 3) ☐ Threshold limit
 - 4) ☐ Resolution
- 57) Magnetic bio sensor is wide used for _____.
- 1) ☐ Blood detection
 - 2) ☒ DNA detection
 - 3) ☐ ECG detection
 - 4) ☐ EMG detection
- 58) CNT stand for _____.
- 1) ☐ Copper Nano Tube
 - 2) ☒ Carbon Nano Tube
 - 3) ☐ Cell Nano Tube
 - 4) ☐ Crystal Nanotube
- 59) The float zone technique is used when a _____ required to produce the single-crystal substrates used in microelectronics and MEMS.
- 1) ☒ Very high purity silicon substrate
 - 2) ☐ GaAs substrate
 - 3) ☐ Uniform distribution of dopants in silicon substrate
 - 4) ☐ All answers are correct



- 60) In piezoresistive sensors and force sensors, maximum displacement and stress of the square membrane occurs respectively at _____.
- 1) ☒ The center and edges
 - 2) ☐ The edges and center
 - 3) ☐ Displacement and stress remain uniform
 - 4) ☐ It cannot be predicted
- 61) _____ of the beam is inversely proportional to the _____ of the beam.
- 1) ☐ Stiffness, slope
 - 2) ☐ Stress, support reaction
 - 3) ☒ Stiffness, deflection
 - 4) ☐ Length, load
- 62) Molecules that form hydrogen bonds with water molecules are hydrophobic.
- 1) ☐ True .
 - 2) ☒ False .
- 63) Straggling means that the ions with same macroscopic parameters penetrating a solid stop at the same depth.
- 1) ☐ True .
 - 2) ☒ False .
- 64) In a comb-drive, the combs are arranged so that they usually touched.
- 1) ☐ True .
 - 2) ☒ False .
- 65) In semiconductors, the changes in geometry is the dominate resistance changes upon deformation.
- 1) ☐ True .
 - 2) ☒ False .