

BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE PILANI, RAJASTHAN
SECOND SEMESTER (2022-23)
FLEXIBLE AND STRETCHABLE ELECTRONICS (EEE F419)

Date: 12-05-2023, Friday

Time: 3 hours

COMPREHENSIVE EXAM

CLOSED BOOK

MM 80

1. (a) A flexible device is to be fabricated using film-on-substrate. The thicknesses of film and substrate are 20 μm and 60 μm , respectively. The bending radius required for the application is 3 cm. Assuming the Young's modulus of film and substrate to be almost same, calculate the location of neutral axis (from the surface) in this structure. Also select the material(s) shown in table below to be used as substrate for this device. Give valid justification.

| Materials | A | B | C | D |
|----------------|--------|--------|--------|--------|
| Failure strain | 0.0012 | 0.0023 | 0.0037 | 0.0011 |

(b) Describe the process steps involved in obtaining silicon crystal silicon ingots from silicon ore quartzite. Support your answer/steps using chemical reactions involved.

[7+ 8 = 15 marks]

2. (a) Write full form and nature (insulator/semiconductor/conductor) of following materials that are used in various flexible devices. Name one device in which these materials are used.

- (i) CIGS
- (ii) ITO

(b) What are the similarities and dissimilarities in the properties of h-BN and Graphene?

(c) In flexible humidity sensor used for wearable applications, how key parameters are monitored and what is the underlying principle of it?

[6 + 4 + 5 = 15 M]

3. (a) Draw the schematic-view of flexible bulk heterojunction (BHJ) Organic solar cell (OSC) mentioning different thin-layers used in the structure. Using band diagrams explain its working principle. How BHJ structure overcomes the challenges involved in the Bilayer OSCs?

(b) Define the parameters; sensitivity, resolution and offset error for analyzing the performance of a sensor. A typical temperature sensor is designed for -50°C to 120°C to give an output of 3.0 V to 1.2 V. Calculate the range, span, input full scale and output full scale.

[13 + 7 = 20 marks]

4. (a) What are Flexible Actuators? Explain (type, properties, challenges) the broad categories of intelligent materials used in fabricating flexible actuators. Name the various energy harvesting mechanism involved in self-powered electronic skin.

(b) Draw the schematic of a Gravure printing. Explain its various tools and its purpose. What are its major challenges and how they get overcome by Gravure offset printing?

[10 + 10 = 20 marks]

5. Explain why gate leakage current is high in a-Si:H TFT on PES as compared to conventional TFTs on glass? How to improve this? Figure 1 shows the plot of square root of drain current as a function of gate voltage for flexible ZnO TFT on BCB. Extract the field-effect mobility and threshold voltage in the saturation region.

Data given for TFT: channel width = 18 μm , channel length = 6 μm , dielectric constant of plastic = $2.7\epsilon_0$, thickness of insulator = 50 nm.

[10 marks]

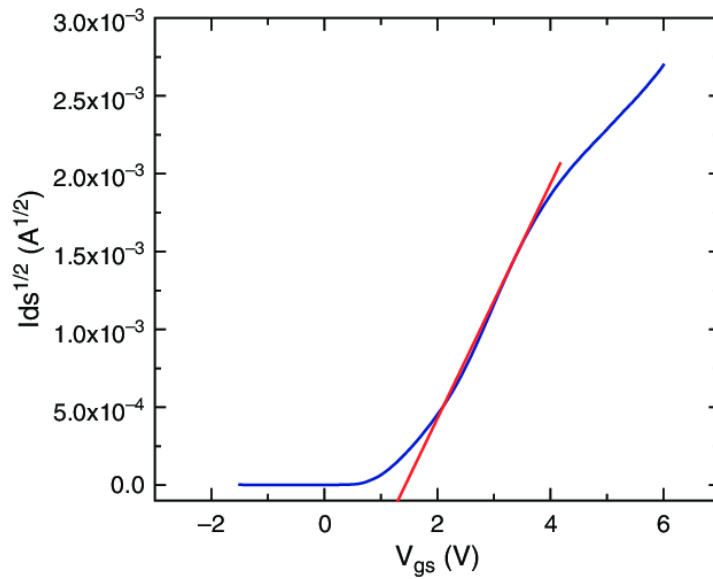


Figure: 1
