

**State University of New York  
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Department of Mechanical and Aerospace Engineering**

**MAE 438/538 Smart Materials  
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Test No. 1

This test consists of 25 problems on 2 pages. Answer all questions in the blue book provided.

1. Why is solder replacement needed in electronics?
2. What is meant by a z-axis conductor that is used in electronic packaging?
3. What is the function of a thermal paste in electronic packaging?
4. Why is carbon black paste exceptionally effective as a thermal paste?
5. What are the material requirements of an EMI gasket?
6. Why is mesoporosity desirable for an absorption material?
7. What are the main advantages of intrinsic smartness over extrinsic smartness?
8. What is meant by piezoresistivity?
9. What is meant by direct piezoelectricity?
10. How can delamination be detected in a continuous carbon fiber epoxy-matrix composite by electrical resistance measurement?
11. Describe a technique for measuring the contact electrical resistivity of the interlaminar interface of a continuous carbon fiber polymer-matrix composite.
12. Describe a technique for attaining self-healing in a structural material.
13. Describe a cement-based thermocouple.
14. Describe a cement-based thermistor.
15. Why is carbon nanofiber more effective than conventional carbon fiber for EMI shielding?

16. How does the volume electrical resistivity of a metal vary with temperature? Explain the variation.
17. What is meant by the percolation threshold?
18. Upon doping a semiconductor with an electron donor, how are the hole concentration and the conduction electron concentration affected?
19. Describe an experimental method for determining the energy band gap of a semiconductor.
20. Describe an advantage and a disadvantage of a thermoplastic-matrix composite compared to a thermoset-matrix composite.
21. Why is the current across a pn-junction much higher in the direction from the p-side to the n-side than in the opposite direction?
22. How can a semiconductor be used as an infrared detector?
23. Give the physical origin behind the piezoresistivity in cement containing short carbon fibers.
24. Describe the main applications of concrete that can sense its own strain.
25. A self-heating structural material should have a resistivity that is not too high and not too low. Why?