

task_kyt15w11e3sempb2_with_calculation

Student Group

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Exercise E2 Resistivity and temperature dependent Resistance (written test, approx. 7 % of a 60-minute written test, SS2023)

The resistivity of a dielectric material is given by the equation $\rho(T) = \rho_0 \exp\left(\frac{E_a}{kT}\right)$ where ρ_0 is a constant, E_a is the activation energy, k is the Boltzmann constant, and T is the absolute temperature. The resistivity of the material is $10^{17} \Omega \cdot \text{m}$ at 20°C . Calculate the resistivity of the material at 55°C if the activation energy is 0.8 eV .

Solution: The resistivity of the dielectric material is $\rho_{\text{PP}}(20^\circ\text{C}) = 10^{17} \Omega \cdot \text{m}$.

For the given material the temperature coefficients in the range of 20°C and 55°C

are given as $\alpha = -0.048 \text{ 1/K}$ and $\beta = +0.00057 \text{ 1/K}^2$.

$$\begin{aligned} R(55^\circ\text{C}) &= R(20^\circ\text{C}) \cdot (1 + \alpha \cdot \Delta T + \beta \cdot T^2 + \dots) \\ &= 80 \text{ G}\Omega \cdot (1 - 0.048 \text{ 1/K} \cdot (35 \text{ K}) + 0.00057 \text{ 1/K}^2 \cdot \Delta T^2) \end{aligned}$$

Calculate the resistance for the dielectric material for 20°C .

Solution

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\begin{align*} R(20 \sim \rm\text{\textdegree}C) \&= \rho \cdot \frac{d}{A} \&= 10^{17} \sim \Omega \\ \rm\text{\text{m}} \cdot \frac{0.8 \cdot 10^{-6} \sim \rm\text{\text{m}}}{1 \sim \rm\text{\text{m}}^2} \end{align*}
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