

task_kyt15w11e3sempb2_with_calculation

Student Group

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resistivity, power, exam ee1 SS2023

Exercise E1 Resistivity and temperature dependent Resistance (written test, approx. 7 % of a 60-minute written test, SS2023)

The conductivity of a dielectric material is given by the Arrhenius equation $\rho(T) = \rho_0 \exp(-E_a/kT)$ where ρ_0 is a constant and E_a is the activation energy. The resistivity of the dielectric material is $\rho(T) = 10^{17} \exp(-E_a/kT) \Omega \cdot m$ at $T = 20^\circ C$ and $10^{10} \Omega \cdot m$ at $T = 55^\circ C$. The temperature coefficients in the range of $20^\circ C$ and $55^\circ C$ are given as $\alpha = -0.048 \text{ 1/K}$ and $\beta = +0.00057 \text{ 1/K}^2$.

Solution

The resistivity of the dielectric material is $\rho(T) = 10^{17} \exp(-E_a/kT) \Omega \cdot m$ at $T = 20^\circ C$ and $10^{10} \Omega \cdot m$ at $T = 55^\circ C$. The temperature coefficients in the range of $20^\circ C$ and $55^\circ C$ are given as $\alpha = -0.048 \text{ 1/K}$ and $\beta = +0.00057 \text{ 1/K}^2$.

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

Calculate the resistance for the dielectric material for $20^\circ C$.

Solution

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