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 resistance of a dielectric material is described by the resistivity and the geometry of the material. The resistivity is calculated by the equation $R=\rho \frac{l}{A}$ where ρ is the resistivity, l the length and A the cross-sectional area. The resistivity of the material is dependent on the temperature. The relation between the resistivity and the temperature can be approximated by the equation $\rho_{\rm PP}(T)=\rho_{\rm PP}(20 ~\rm °C) \cdot e^{-B(T-20 ~\rm °C)}$ where B is a material constant and T is the temperature in °C. The resistivity at $20 ~\rm °C$ is $\rho_{\rm PP}(20 ~\rm °C)=10^{17} ~\Omega \rm m$. The material constant B is 0.8. The dielectric material is placed between two plates of $A=100 ~\rm mm^2$ and $l=25 ~\rm µm$.

Result

The resistivity of the dielectric material is $\rho_{\rm PP}(20 ~\rm °C)=10^{17} ~\Omega \rm m$.

For the given material the temperature coefficients in the range of $20 ~\rm °C$ and $55 ~\rm °C$ are given as $\alpha =-0.048 ~\rm 1/K$ and $\beta=+0.00057 ~\rm 1/K^2$.

$$\begin{aligned} R(20 ~\rm °C) &= 8016 ~\rm G\Omega \\ R(55 ~\rm °C) &= 80 ~\rm G\Omega \end{aligned}$$

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

Solution

Calculate the resistance for the dielectric material for $20 ~\rm °C$.

Solution

$$\begin{align*} R(20 ~\rm °C) &= \rho\cdot {{d}\over{A}}\\ &= 10^{17} ~\Omega \rm m \cdot {{0.8\cdot 10^{-6} ~\rm m}\over{1 ~\rm m^2}} \end{align*}$$