task_kyt15w11e3sempb2_with_calculation

Student Group

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resistivity, power, exam ee1 SS2023

Exercise E1 Equivalent linear Source
(written test, approx. 7 % of a 60-minute written test, SS2023)

Calculate the resistance for the dielectric material for $55 ~\rm °C$.

(The exact relation between temperature and resistance for polymers is better described by the $B25$-value in an exponential formula. In this case, the best fit would be $B25 = 15'000$ for T between $20 ~\rm °C$ and $100 ~\rm °C$)

The given film capacitor has an internal surface of $A=100 ~\rm cm^2$ and a distance between the plates of $d=0.8 ~\rm µm$.

Result

Solution

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

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{align*} R(55 ~\rm °C) &= 80.6 \rm G\Omega \end{align*}

\begin{align*} 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{align*}

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

Solution

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