**L3. Stress and Strain**

*Application:*

*Consider a copper wire with a rectangular section 1x0.5mm and a length of 10mm that is fixed between two rigid components. Assume a yield strength of 50MPa for pure copper and a thermal expansion coefficient of 17x10-6°C-1. The elastic modulus of copper is 125GPa.*

*If the temperature is risen from 24°C to 50, 100, 150 and 200°C, find the stresses in the wire. At which temperature would the wire yield given the rising stress? Is this possible?*

σ = E\*α\*ΔT -> thermal stress

E = 125 GPa = 125\*10^9 Pa

α = 17\*10^-6 °C^-1

ΔT = Tfinal - Tinitial

Tinitial = 24 °C

For

Tfinal = 50 °C => ΔT1 = 50-24 = 26 °C => σ1 = 55.25 MPa

Tfinal = 100 °C => ΔT2 = 76 °C => σ2 = 125\*(10^9)\*17\*(10^-6)\*76 = 161.5 MPa

Tfinal = 150 °C => ΔT3 = 126 °C => σ3 = 267.75 MPa

Tfinal = 200 °C => ΔT4 = 176 °C => σ4 = 374 MPa

The yield strength of pure Cu is given at 50MPa

For 50°C => the stress exceeds the yield strenght (55.25>50 MPa)

Once the stress reaches the yield strength => plastic deformation (the wire won’t return to its original shape when cooled).

Since the wire is constrained between rigid supports => can’t expand freely => permanent deformation

For σ Cu = 50 MPa => 125\*(10^9)\*17\*(10^-6)\*ΔT = 50\*10^6 =>

=> ΔT = (50\*10^6) / 125\*(10^9)\*17\*(10^-6) = 23.53 °C

Tyield = 24+23.53 = 47.5 °C => the wire will yield at 47.5 °C