Case study: electronic packaging
High stiffness, minimizing BOTH thickness and mass



Bidimensional objects
Panel taken as reference
Remember equation for thickness and mass

$$\text{Thickness, } w = FS_w \cdot \frac{1}{E^{\frac{1}{3}}}$$

$$\text{Mass, } m = FS_m \cdot \frac{\rho}{E^{\frac{1}{3}}}$$



Let's optimize both thickness and mass

$$w_0 = FS_w \cdot \frac{1}{E_0^{\frac{1}{3}}} \qquad m_0 = FS_m \cdot \frac{\rho_0}{E_0^{\frac{1}{3}}}$$

Standard

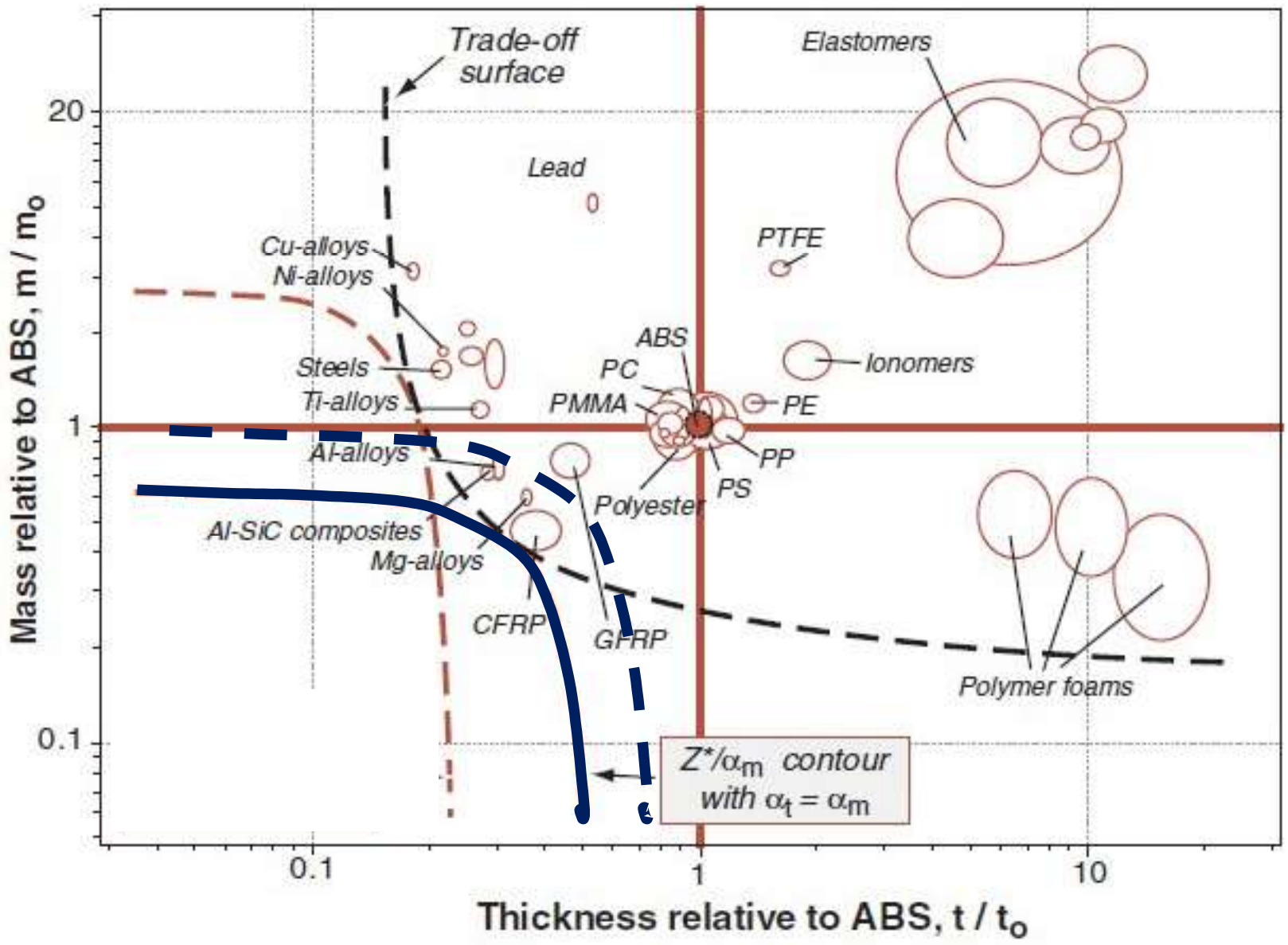
Relative thickness and relative mass: structural factors are no longer needed

$$\frac{w}{w_0} = \frac{FS_w \cdot \frac{1}{E^{\frac{1}{3}}}}{FS_w \cdot \frac{1}{E_0^{\frac{1}{3}}}} = E_0^{\frac{1}{3}} \cdot \frac{1}{E^{\frac{1}{3}}}$$

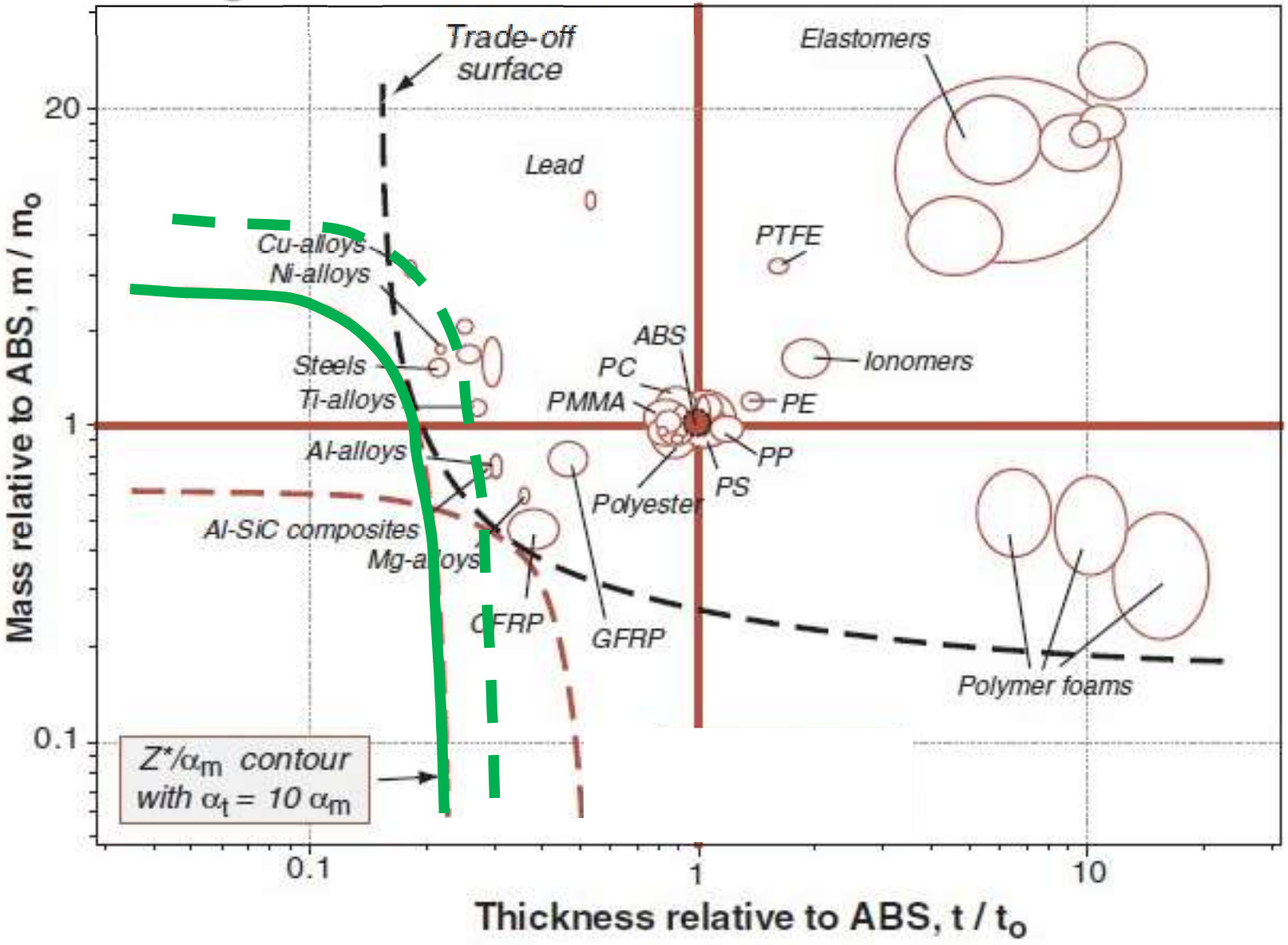
Relative thickness is a function of modulus

$$\frac{m}{m_0} = \frac{FS_m \cdot \frac{\rho}{E^{\frac{1}{3}}}}{FS_m \cdot \frac{\rho_0}{E_0^{\frac{1}{3}}}} = \frac{E_0^{\frac{1}{3}}}{\rho_0} \cdot \frac{\rho}{E^{\frac{1}{3}}}$$

Relative mass is a function of modulus and density


Trade-off surface
Elastomers
Lead
PTFE
Cu-alloys
Ni-alloys
ABS
PC
PMMA
Ionomers
PE
Steels
Ti-alloys
Al-alloys
PP
PS
Polyester
Al-SiC composites
Mg-alloys
CFRP
GFRP
Polymer foams
Z*/αm contour with αt = αm
20
1
0.1
0.1
1
10
Mass relative to ABS, m / mo
Thickness relative to ABS, t / to

Favouring low thickness….



Favouring low mass….

