Window component characteristics

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- Panes and Screens
- Shading Devices
- Frames and Spacers

Panes and Screens

Most important properties

- Spectral Selectivity controls
  - visible Transmittance / Reflectance
  - solar Transmittance / Reflectance
  - radiative losses
- Scattering Behaviour

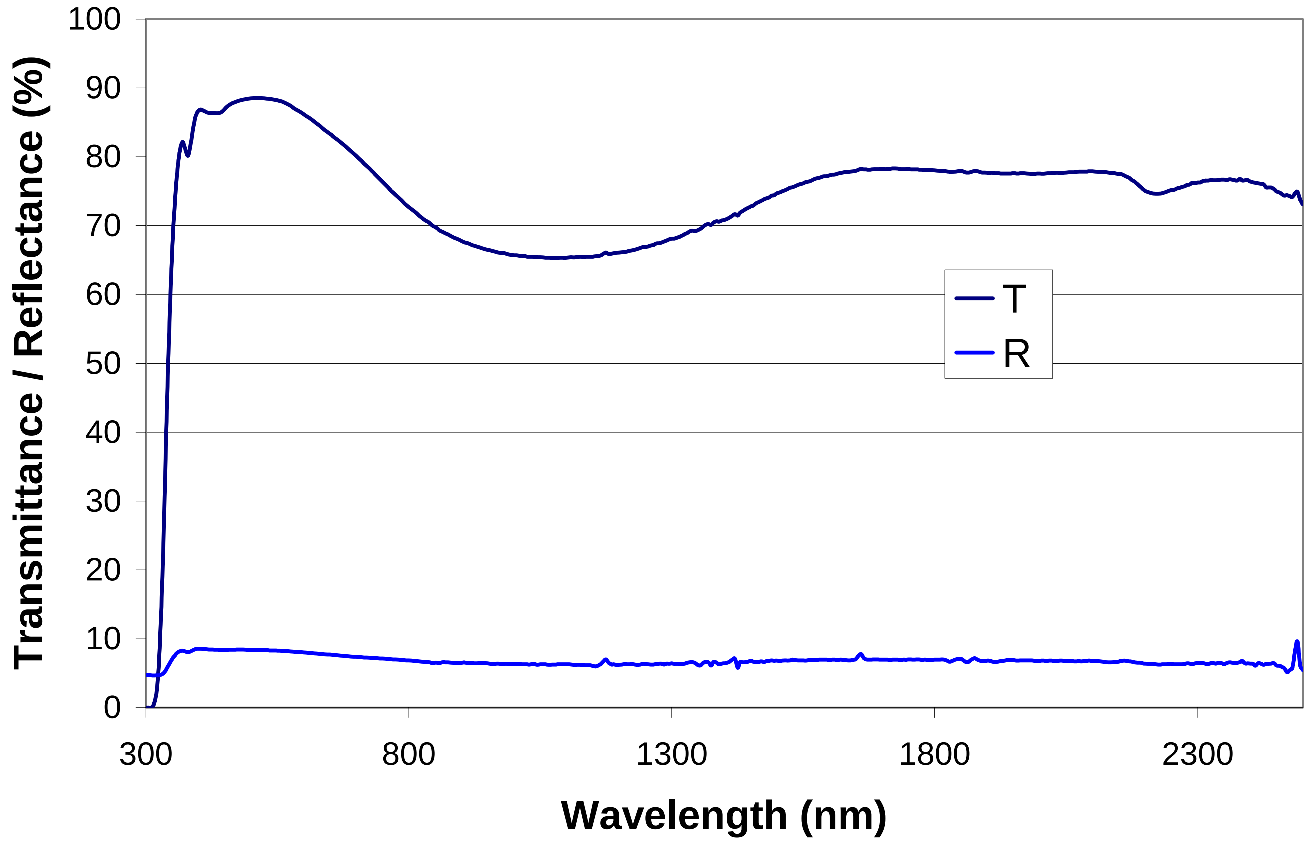
Examples of Important Spectrally Selective Materials in Solar Energy Conversion

- **Glass and glazing products**
  - Low emittance coatings
  - Solar gain control coatings
  - Smart windows, e.g. electrochromics
- **Daylighting**
  - Redirectional materials
  - Reflectors
- **Radiative cooling**
  - Selective paints
- **Absorber surfaces for solar collectors**

Different Pane Types

- Clear Float Glass (uncoated)
- Softcoated Low-E panes
- Hardcoated low-E panes
- Absorbing solar control glass
- Reflecting solar control glass

Optical Properties of Clear Float Glass



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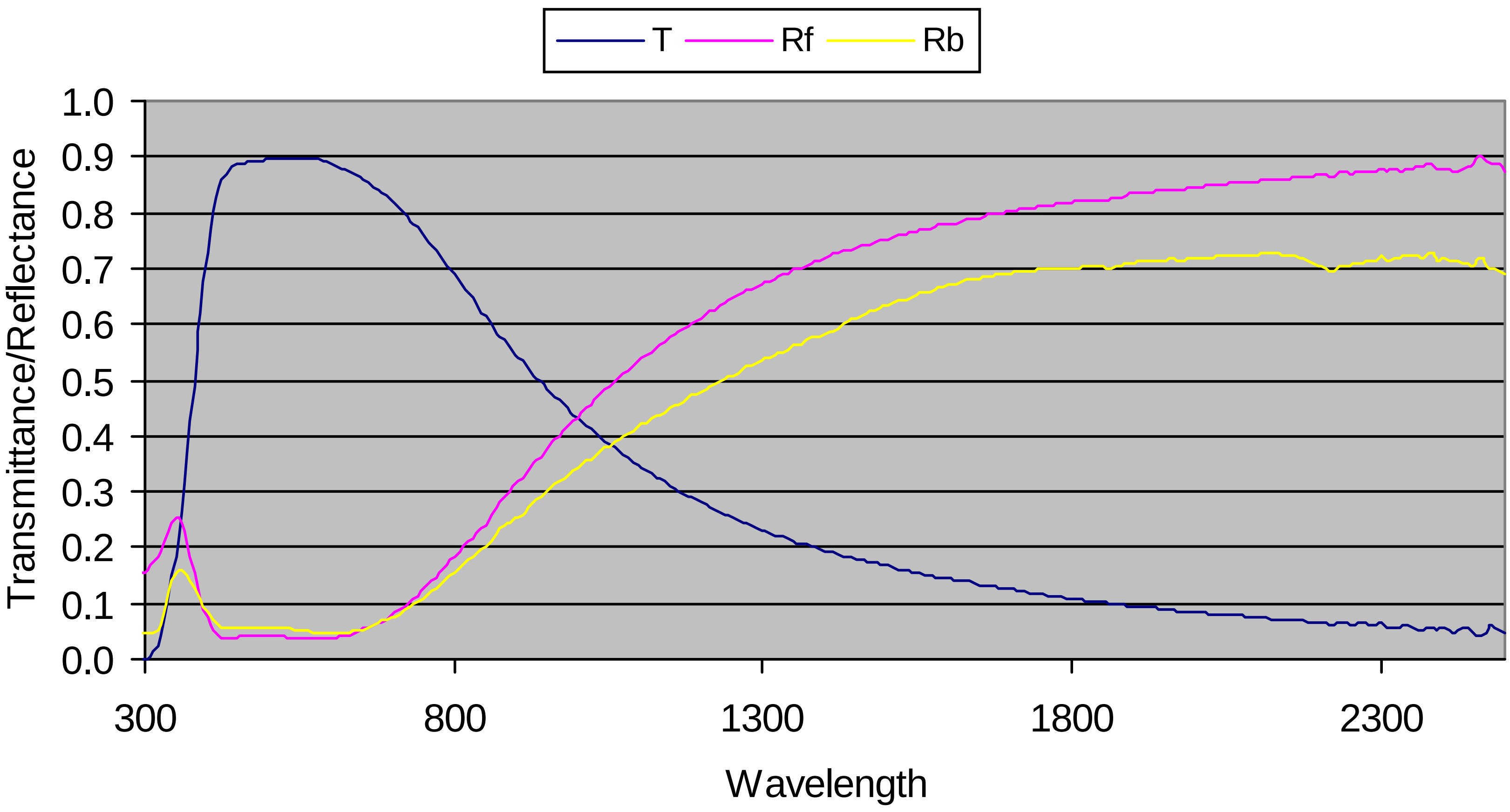
Glazing used for Heating Dominated Climates

- Desired properties:
  - *High thermal resistance* (low U-value to minimise energy loss)
  - *High solar gain* (maximise potential for passive solar gain)
  - *High visible transmittance* (maximise potential for use of daylight)

Low-E coated glass

(iplus neutral s(89/63): : Tvis= 0.89; Tsol = 0.63; E = 0.04)



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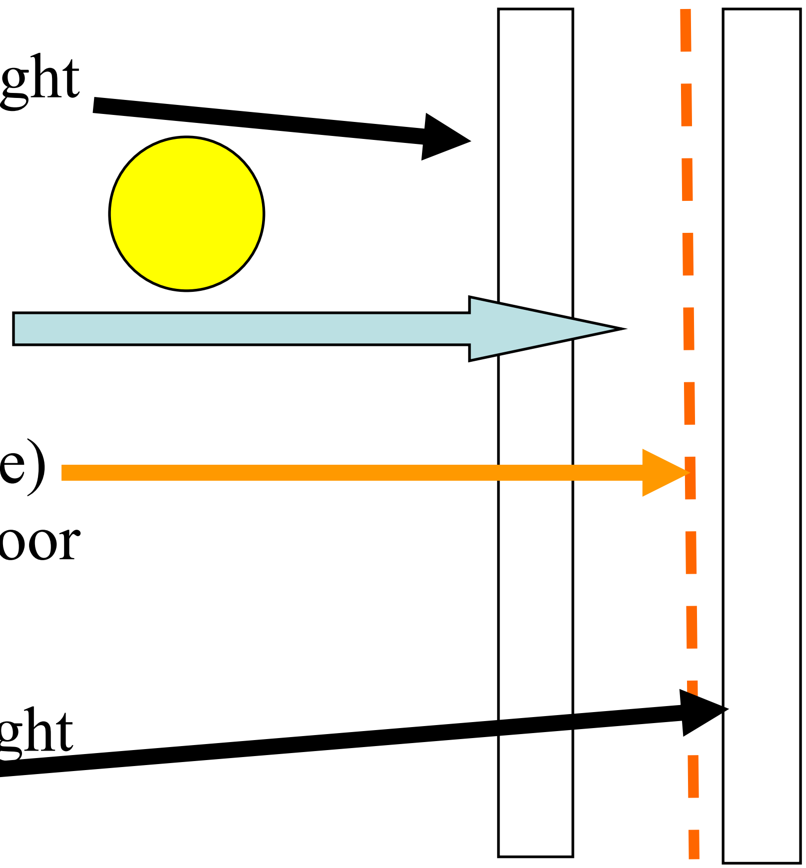
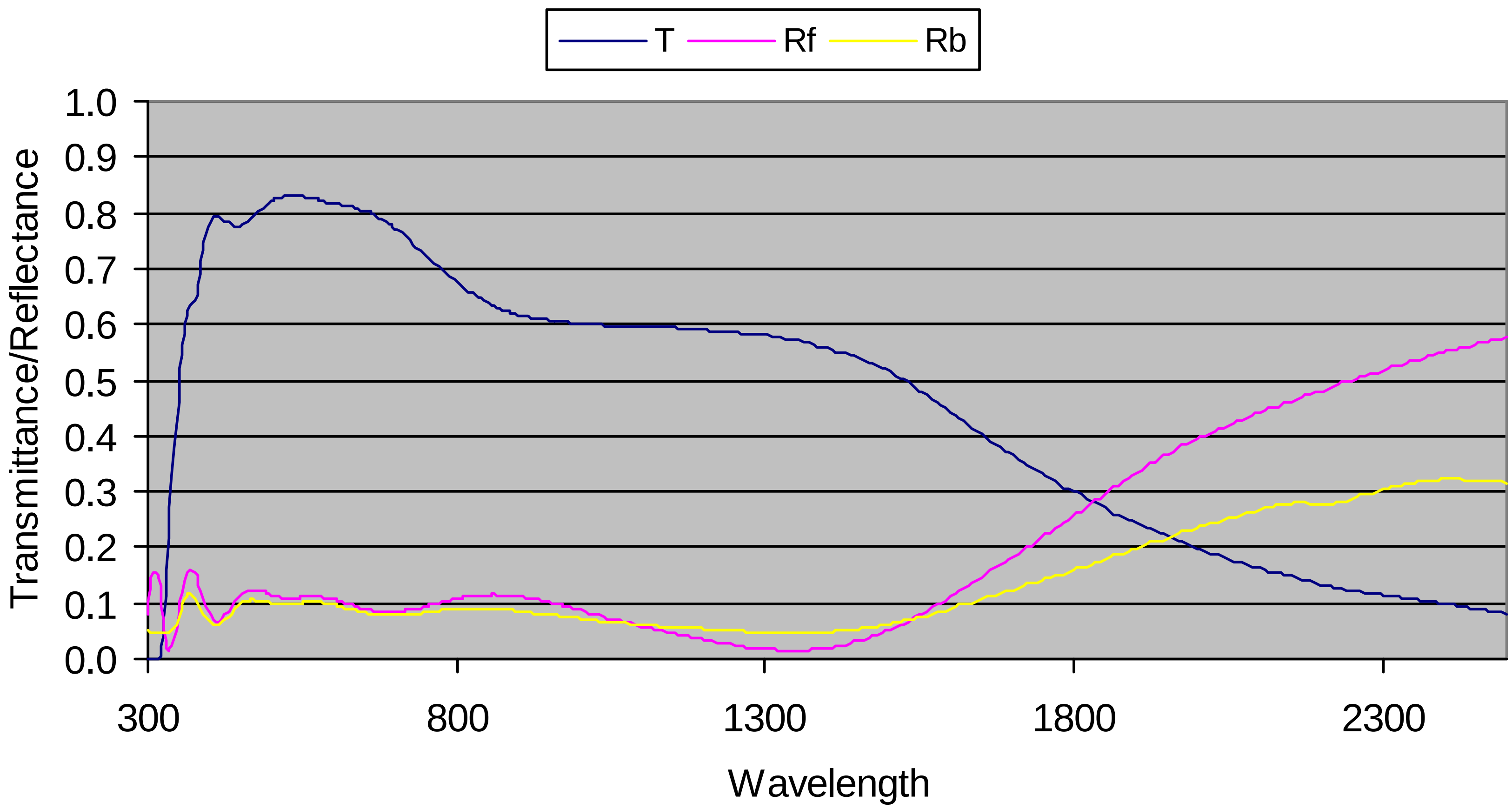
Glazing for maximising passive solar gain: Low-e coating is positioned on Surface 3 - windows can be net gainers of energy even in a cold climate



- clear outer pane maximises light and solar heat gain
- low-conductivity gas (e.g. Argon)
- ‘hard’ low-e coat (high g-value) reflects longwave heat and is poor emitter of that heat
- clear inner pane maximises light and solar heat gain

Low emittance hardcoated glass for high solar gain and low thermal loss

(K-glass (82/68): : Tvis= 0.82; Tsol = 0.68; E = 0.17)



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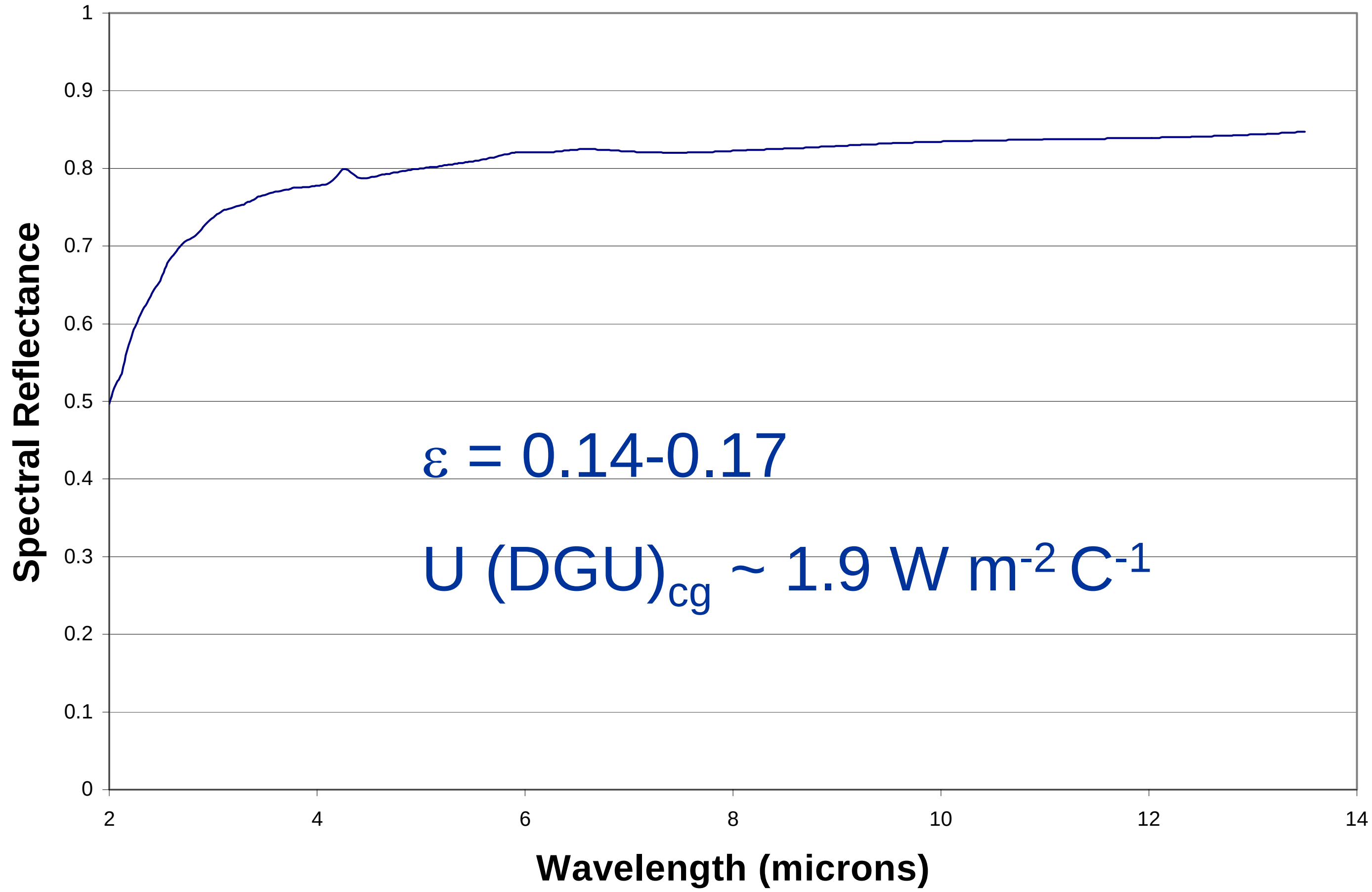
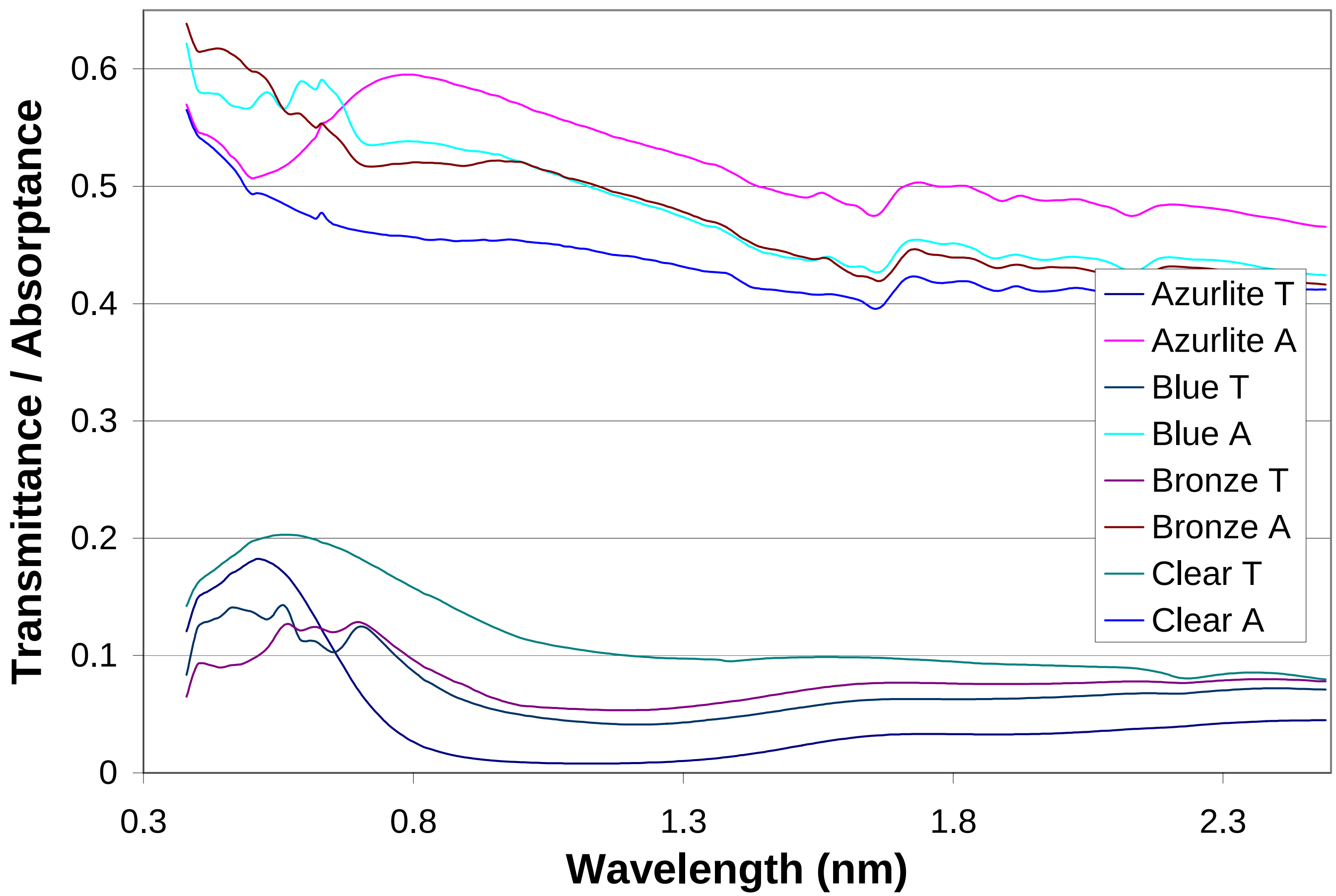
Infrared spectral reflectance of Pilkington K GLASS (low emittance hard coated glass)



Absorption in solar control coatings



Solar Gain Control : the old way & the new way !

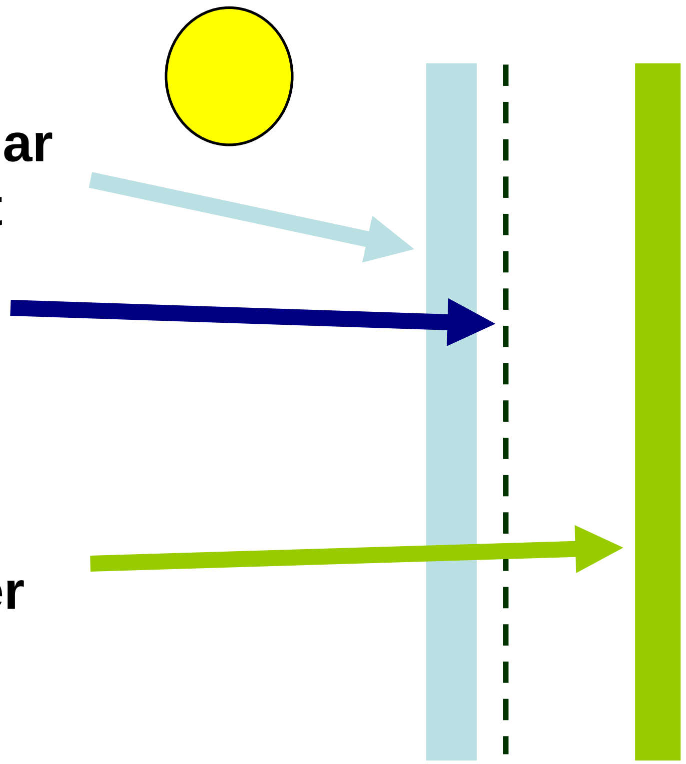
Two glazings with the same total solar energy transmittance

$g = 0.40$, $T_{vis} = 0.14$ **$g = 0.41$, $T_{vis} = 0.63$**

High absorption in the glazing leads to a large secondary thermal radiation contribution to the total solar energy transmittance

Cool glazing configuration: solar control low-e surface located on Surface 2 - cuts solar heat gain without greatly sacrificing daylight, yet sunlit glass does not become a radiator !

Key elements:



- **(optional) selective tint absorbs solar near-infrared more than visible light**
- **spectrally selective low-e coating suppresses inward heat flow and reduces near-infrared solar transmission**
- **second pane puts convection buffer between outer pane and building's occupants**

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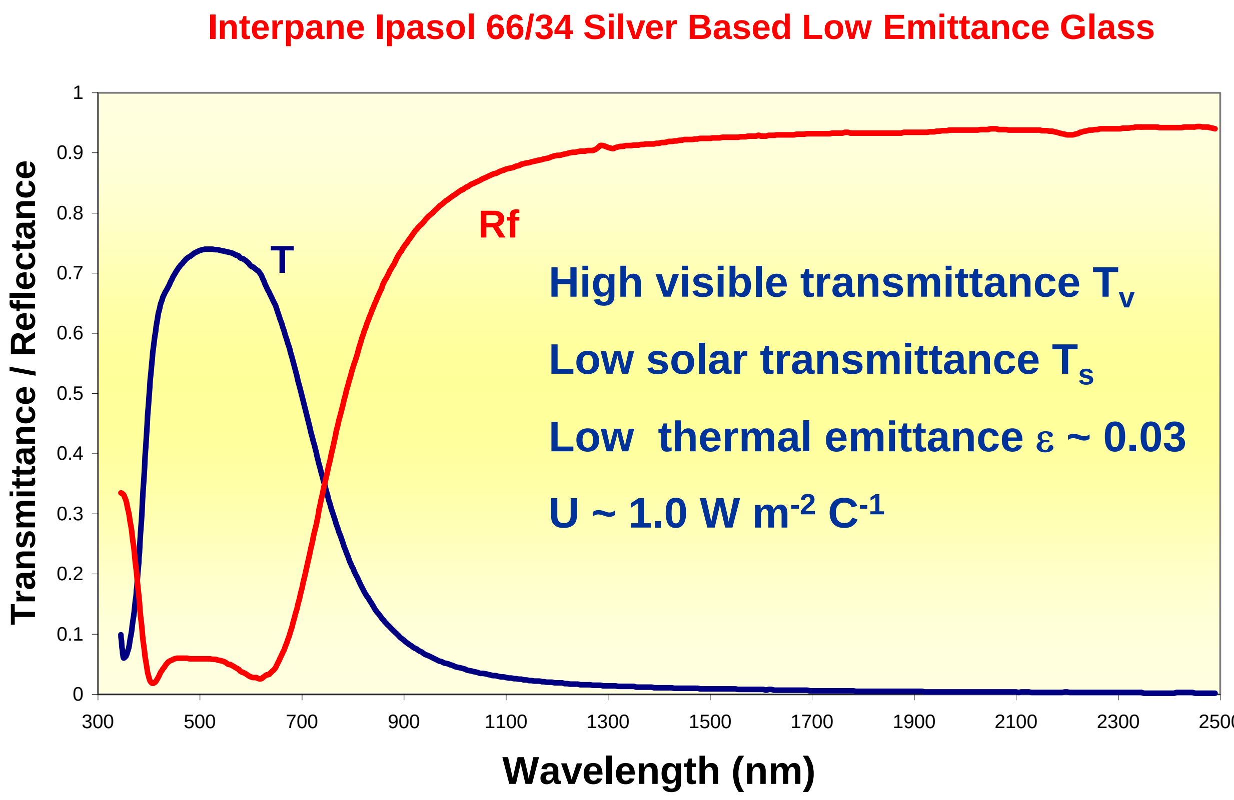
Optical properties of cool silver (reflecting solar control) based coated glass



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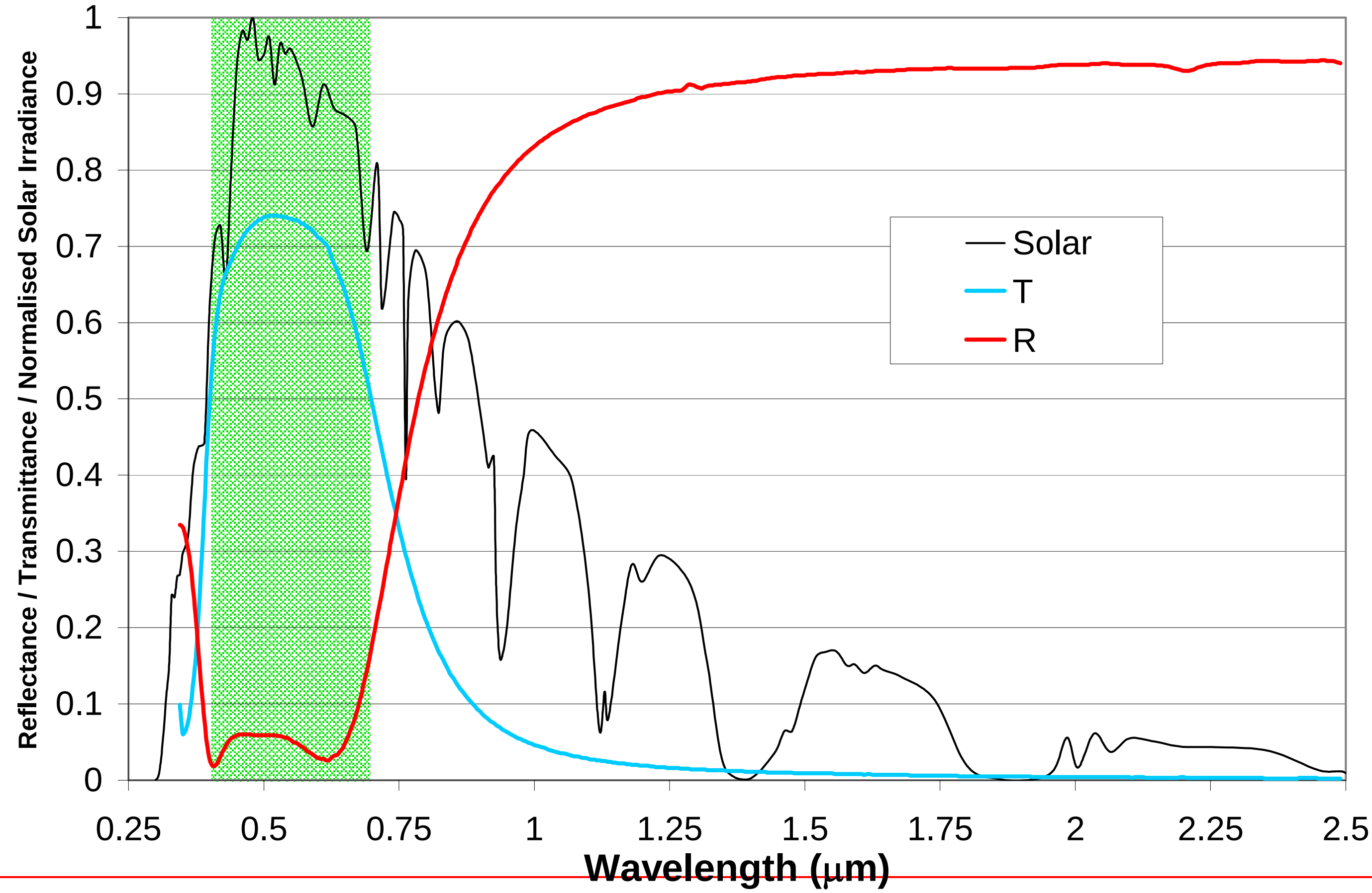
Optical properties of Cool silver based coated glass compared to solar spectrum



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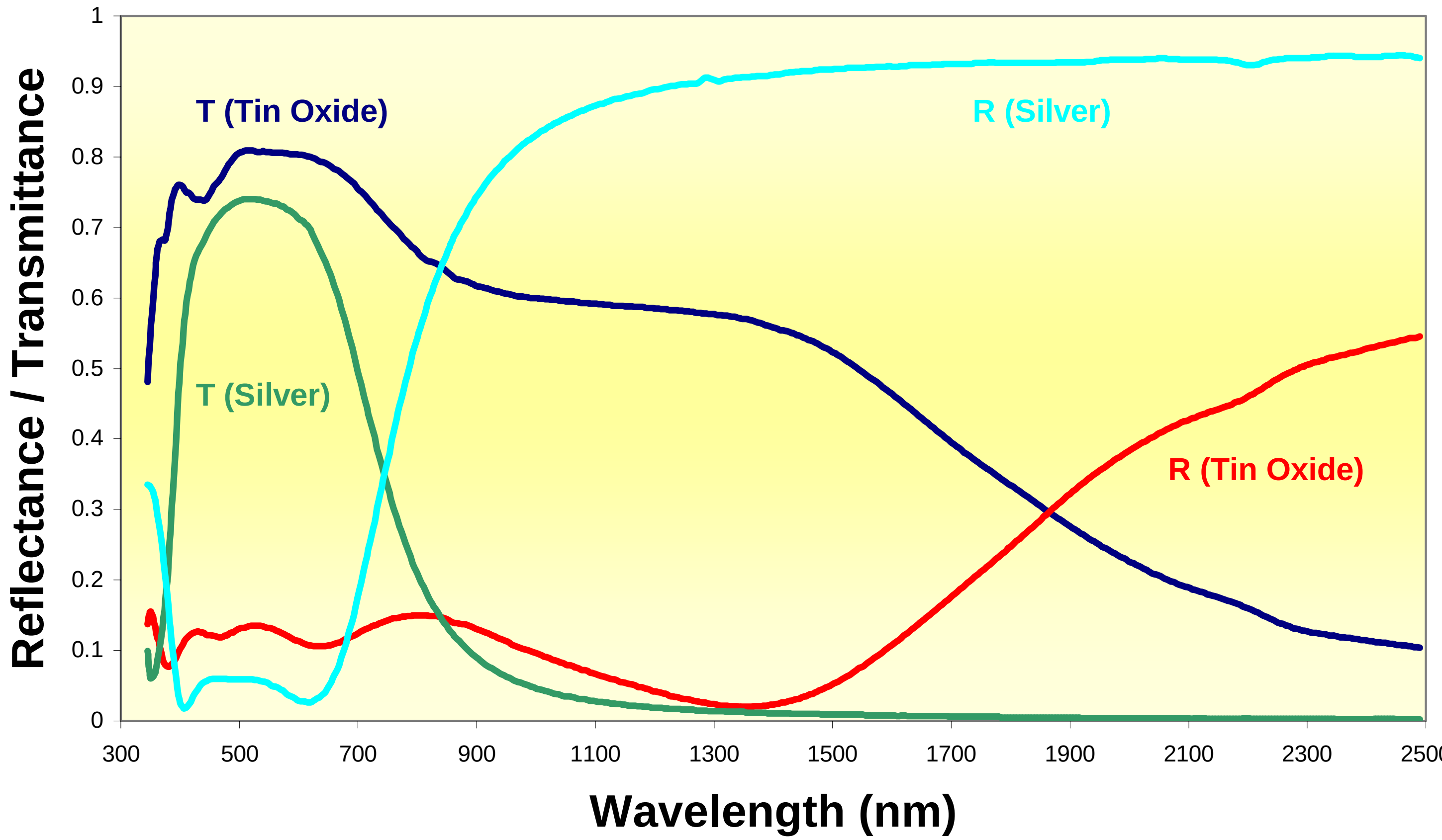
Comparison of reflecting solar control glass and hardcoated low-e



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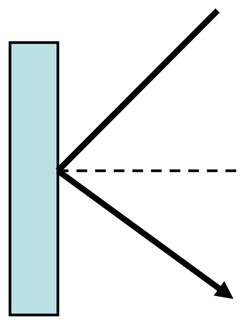
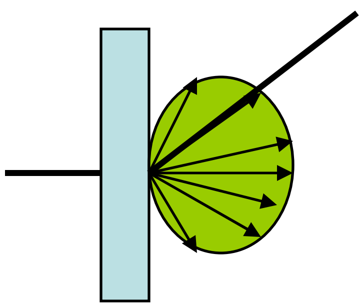
Scattering Behaviour

- When direct beam radiation is reflected or transmitted by a material the reflected component may be either:
  - Specularly reflected (mirror like)

    directional-directional (regular)
  - Scattered or diffusely reflected

    near-normal hemispherical





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Shading Devices

Mostly used Devices Types

- Venetian Blind
- Fixed slat shading device
- Concertina blind or pleated blind
- Screen or Roller blind
- Lamellas

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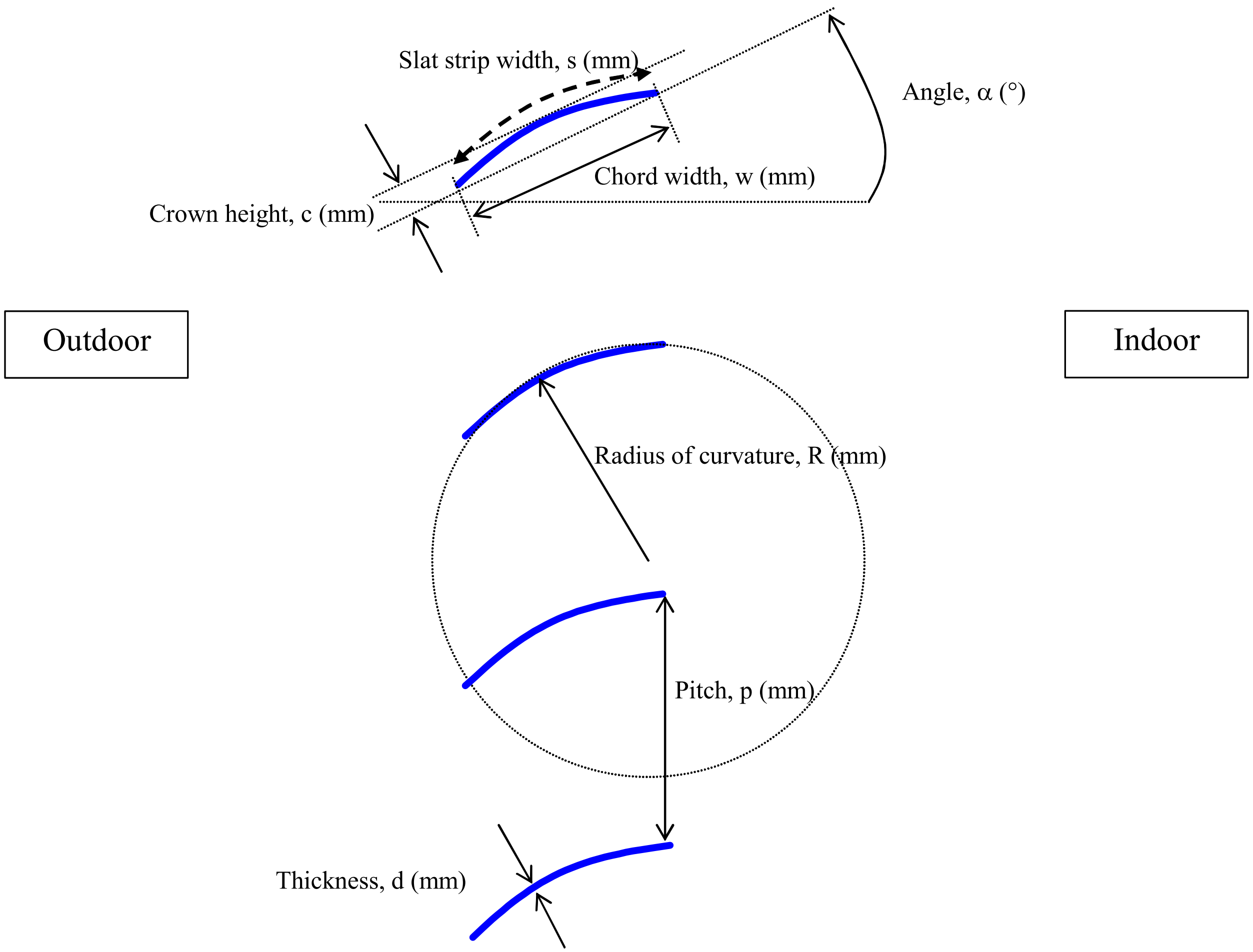
Venetian and fixed slat blind



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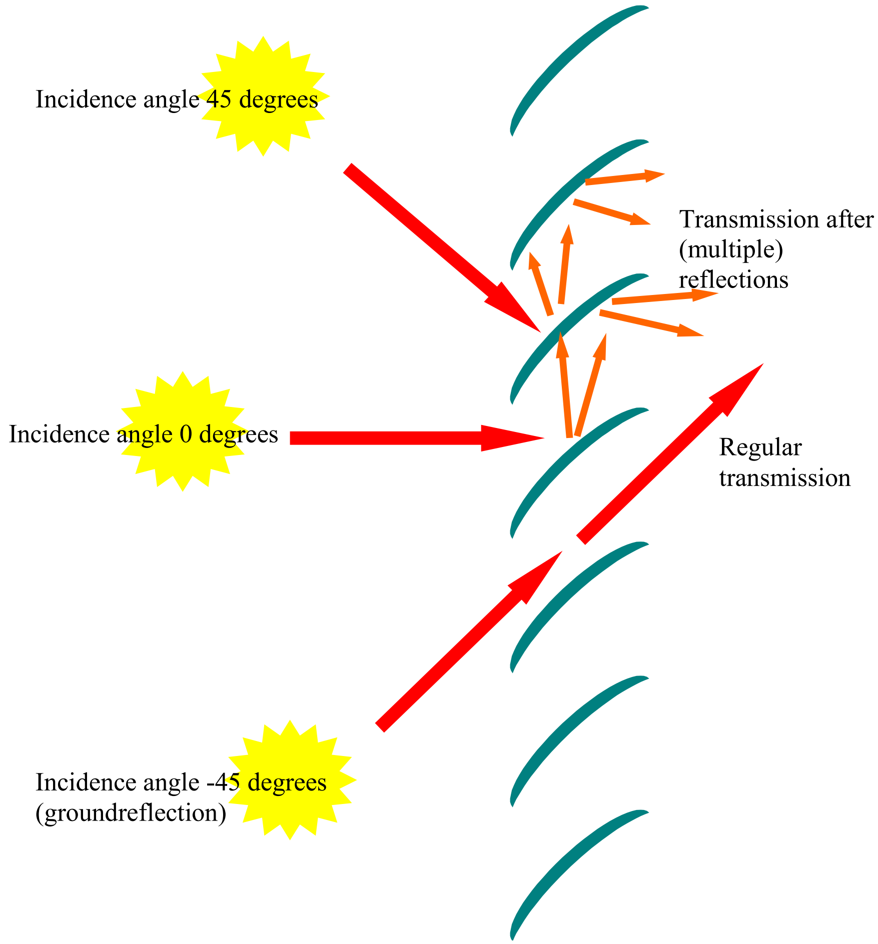
Shading devices: illustration



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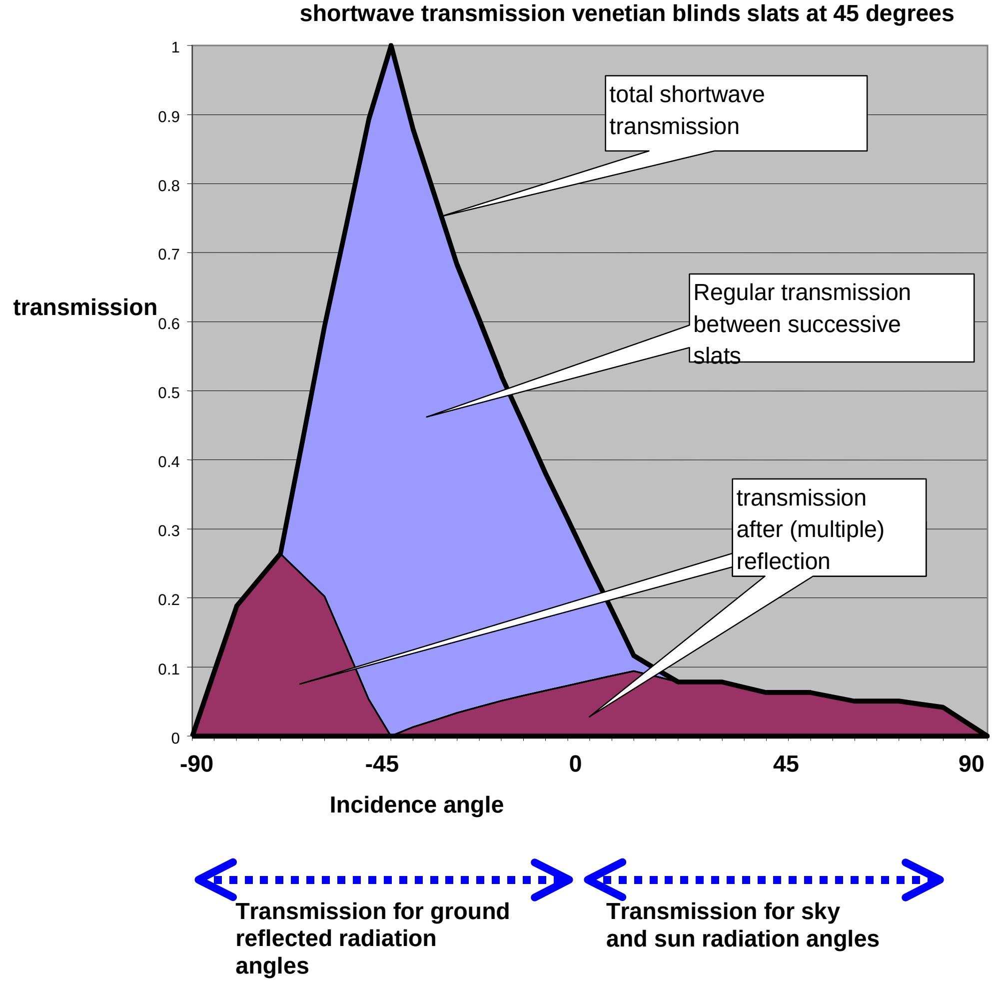
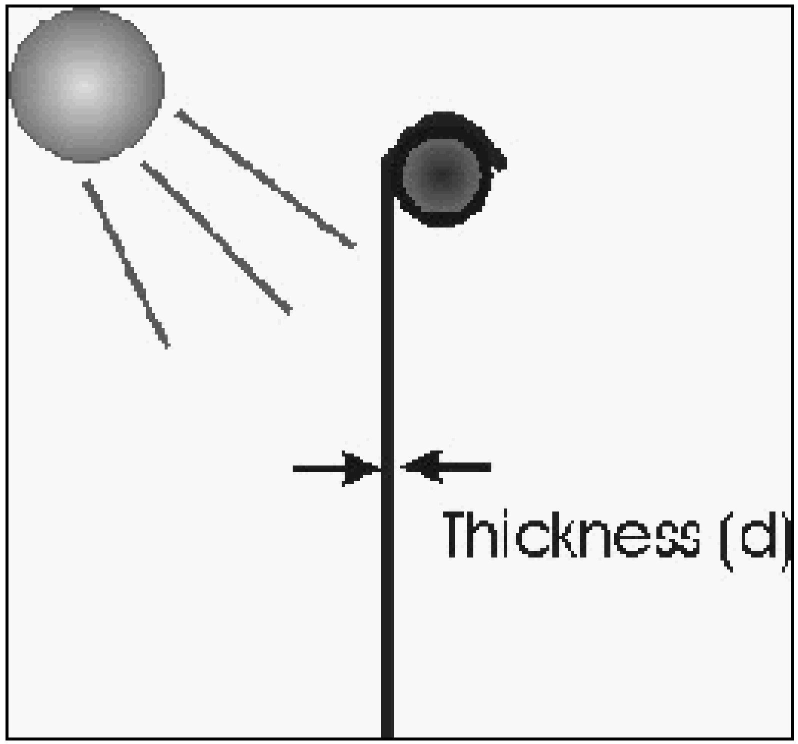
Incident angle and solar transmission



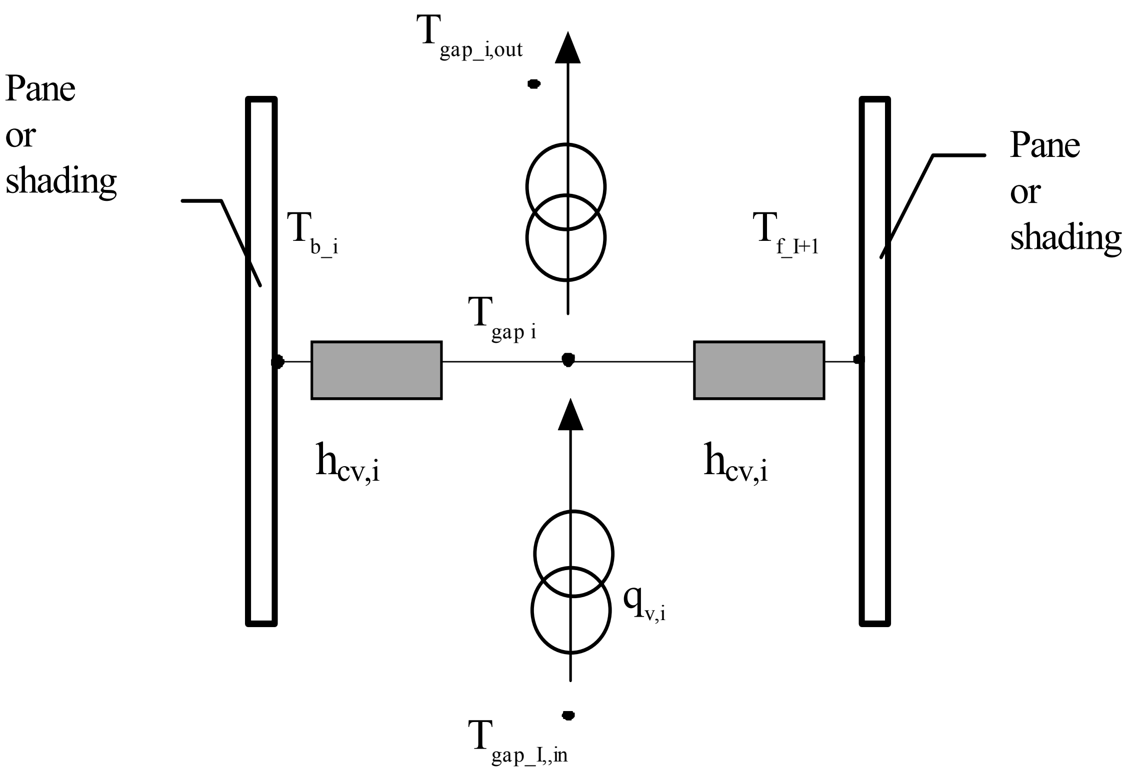
Screen or roller blind

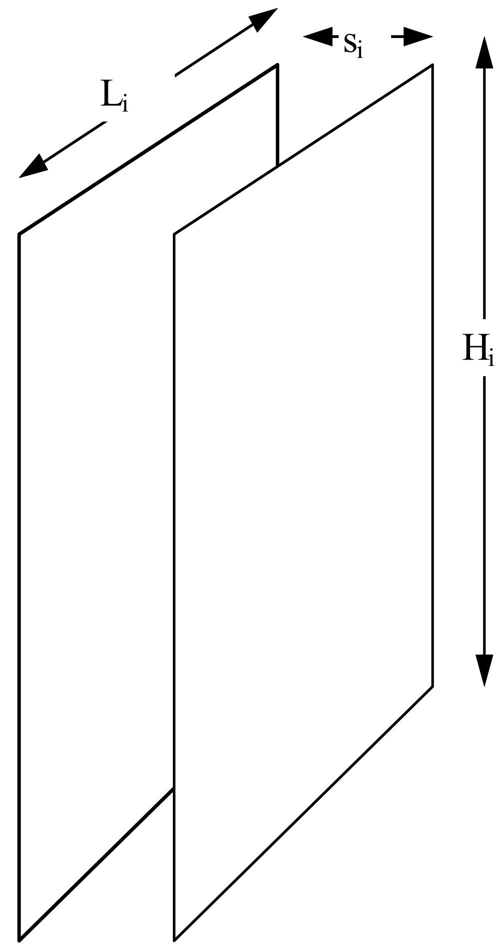


Mounting possibilities of Blinds

- Blind may be positioned in one of three positions:
  - Internal (inside of the glazing)
  - External (outside of the glazing)
  - Between the glazing panes (Interstitial)

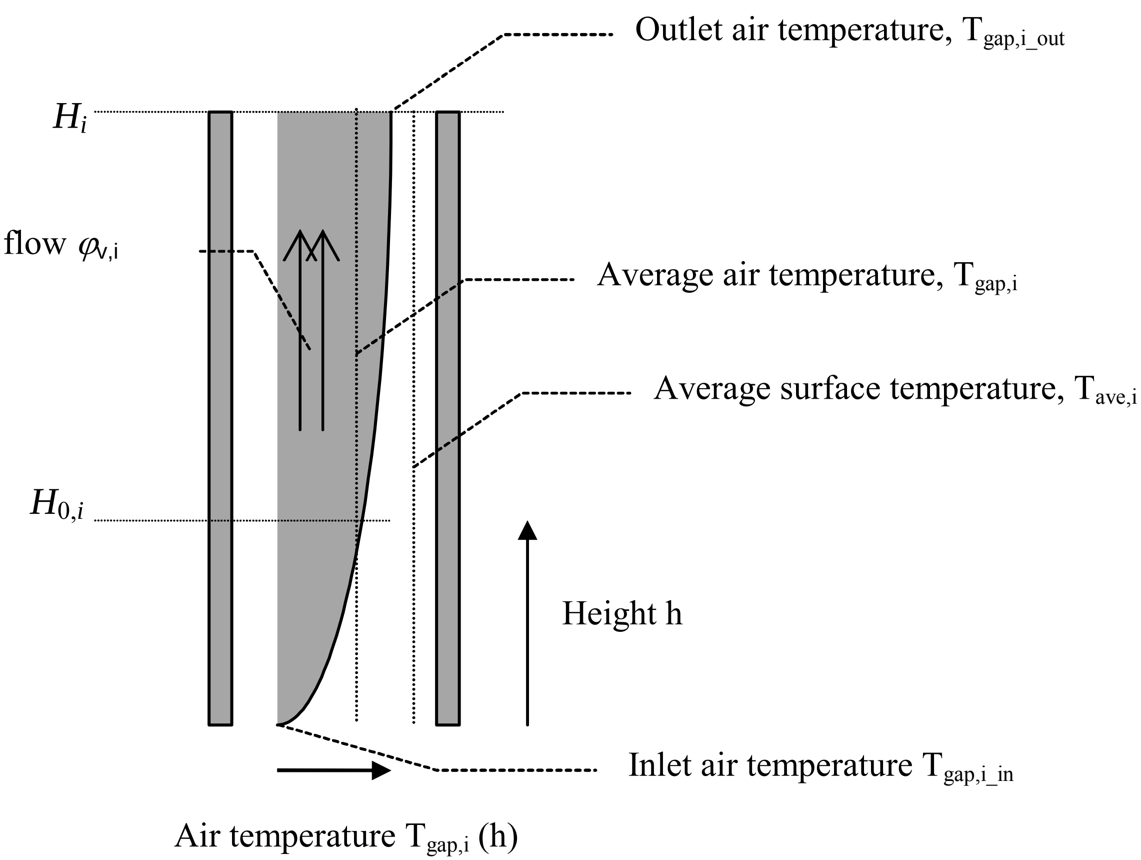
Ventilated or unventilated Gaps





Ventilated cavity

ISO DIS 15099

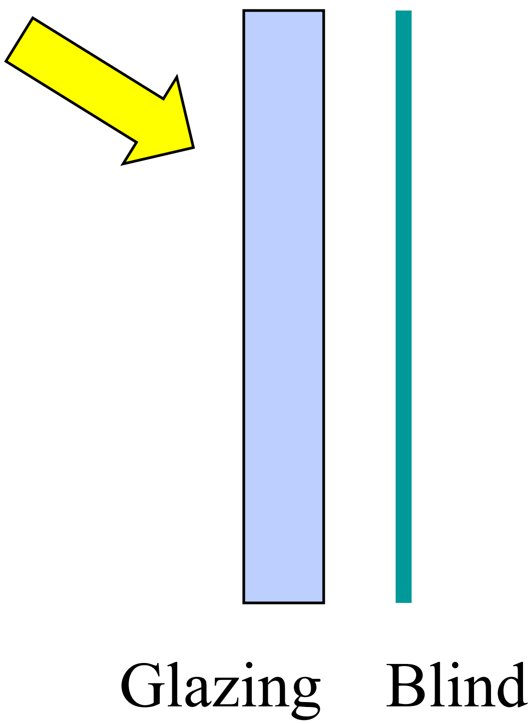


Solar Protection : Internal Blind

Maximising the Blind solar reflectance minimises the total solar gain

Blind on the **inside of the glazing**

Formula and coefficient according to prEN 13363-1 (1998)



$$\mathbf{g}_{\mathbf{total}} = \mathbf{g}\left(1 - \mathbf{g}\rho_{\mathbf{SB}} - \alpha_{\mathbf{SB}}\frac{\Lambda}{\Lambda_{\mathbf{2}}}\right)$$

Where Λ represents the effective heat transfer through the configuration defined as

$$\Lambda = \frac{1}{\left(\frac{1}{U} + \frac{1}{\Lambda_2}\right)} \quad with\, \Lambda_2 = 18\, Wm^{-2}K^{-1}$$

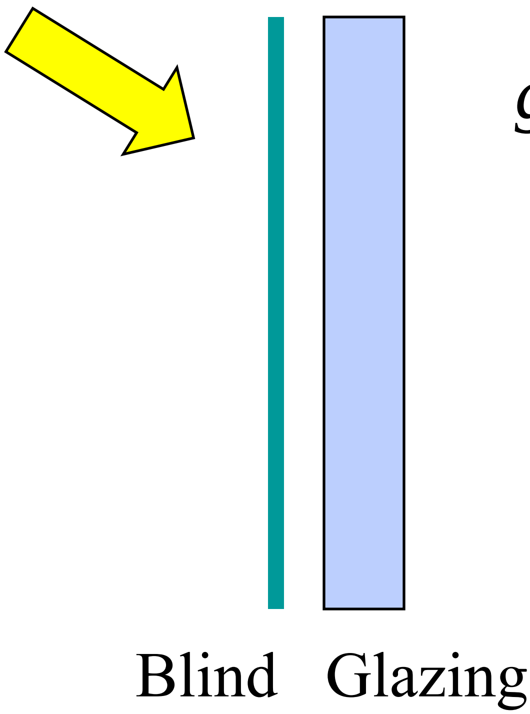
where U is the thermal transmittance, or heat loss coefficient, of the glazing without the blind and $\Lambda 2$ assumes the value 18 W m^{-2} $^{o}K^{-1}$.

Solar Protection : External Blind

Total solar energy transmittance g-value

Blind on the **outside of the glazing**

Formula and coefficients according to prEN 13363-1 (1998)



$$g_{total} = \tau_B\, g + \alpha_B \frac{\Lambda}{\Lambda_2} + \tau_B (1 - g) \frac{\Lambda}{\Lambda_1}$$

where $$\Lambda = \frac{1}{\frac{1}{U} + \frac{1}{\Lambda_1} + \frac{1}{\Lambda_3}}$$

where $\Lambda_1 = 6$ W/m^2 K; $\Lambda_2 = 18$ W/m^2 K

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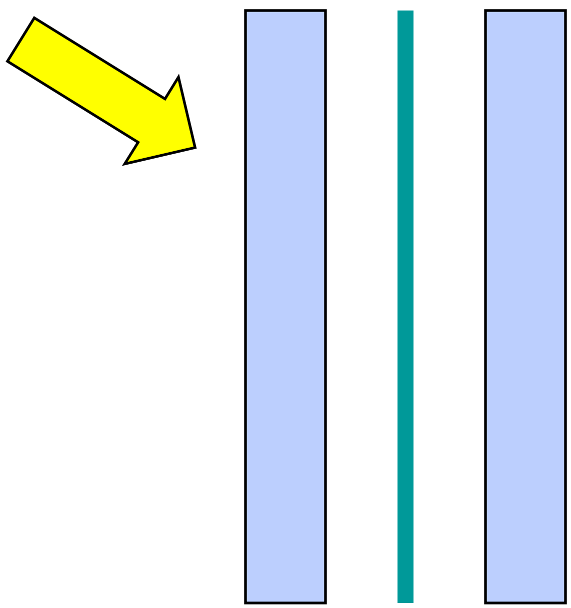
Solar Protection : Interstitial Blinds (for unventilated air spaces)

Blind in between the glazing

Formula and coefficient according to prEN 13363-1 (1998)



Glazing Blind Glazing

$$g_{total} = g\,\tau_B + g\,(\alpha_B + (1-g)\,\rho_B)\,\frac{\Lambda}{\Lambda_3}$$

where $$\Lambda = \frac{1}{\frac{1}{U} + \frac{1}{\Lambda_3}}$$

where $\Lambda_3 = 3$ W/m^2 K

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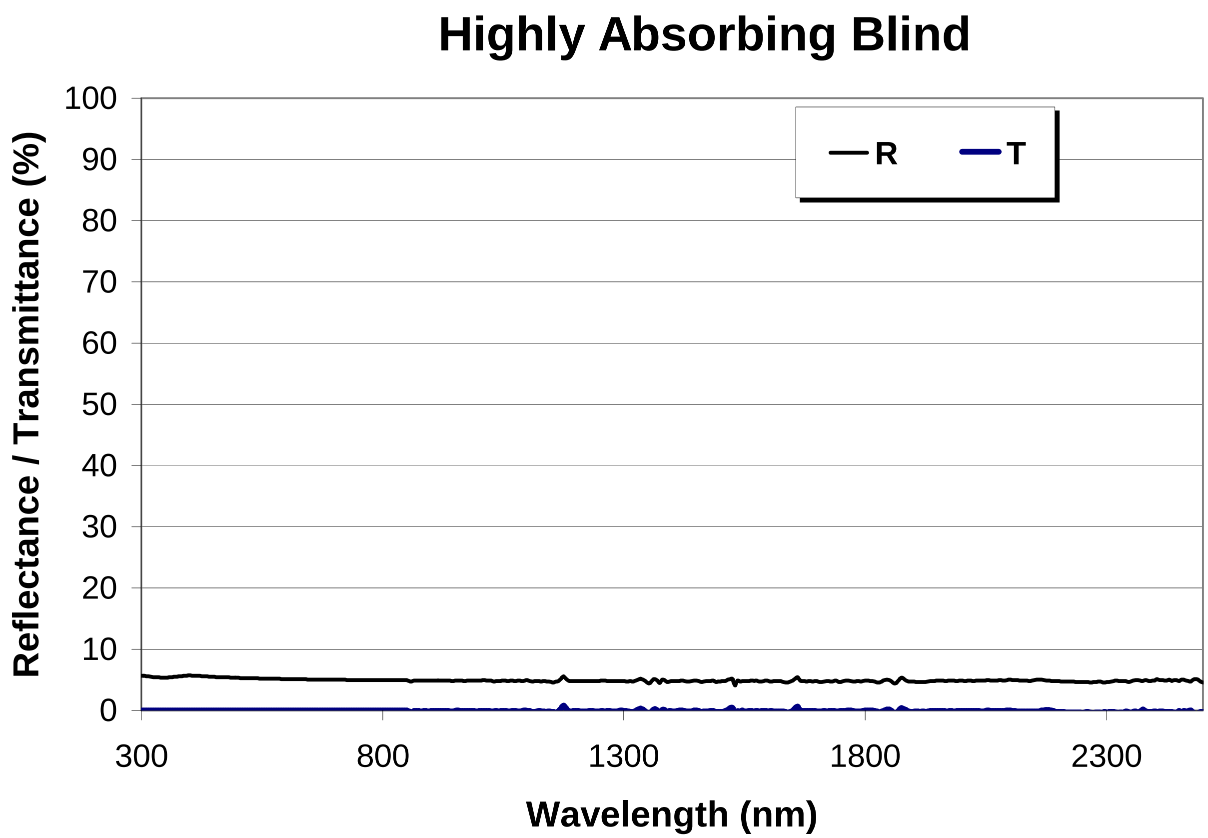
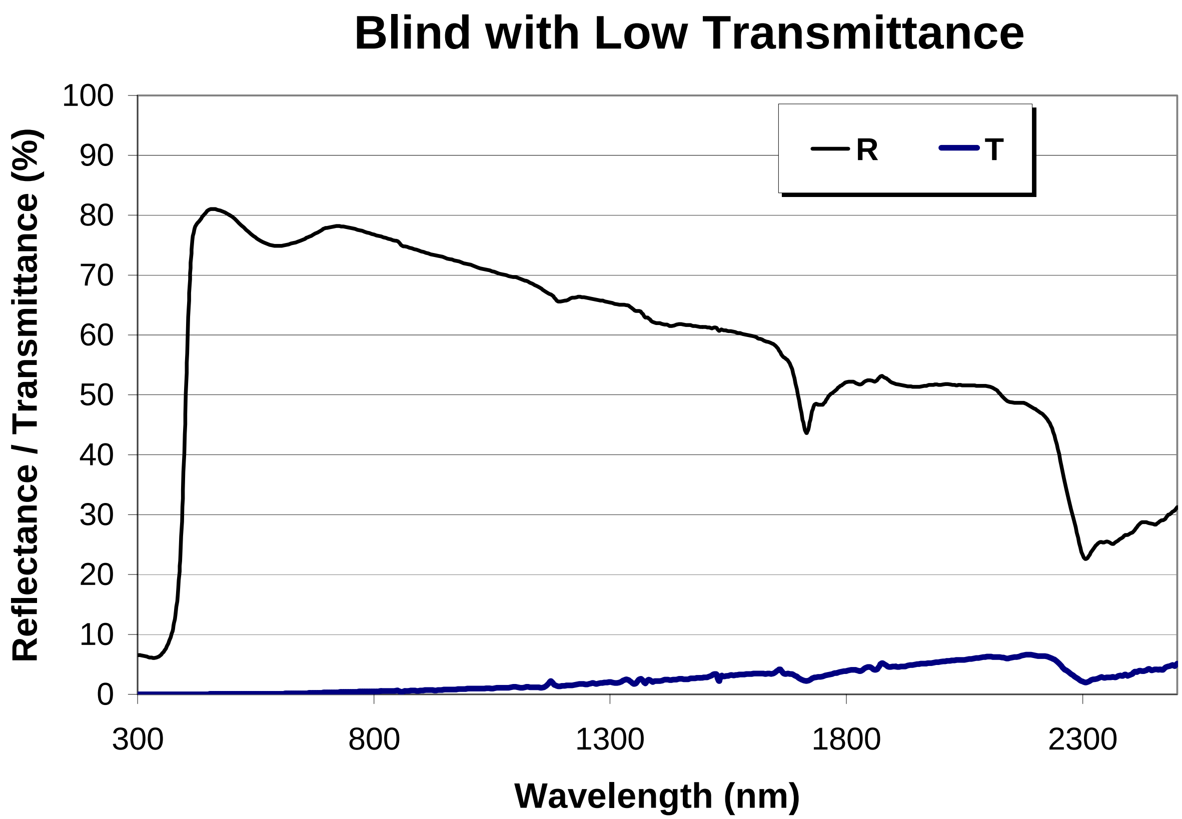
Integrated optical properties of blinds

Types of blinds	Solar Reflectance ρ_sb	Solar Transmitance τ_sb	Solar Absorptance α_sb
Absorptive Blind	0.05	0.00	0.95
Reflective Blind	0.70	0.01	0.29
Transmissive blind	0.61	0.12	0.27

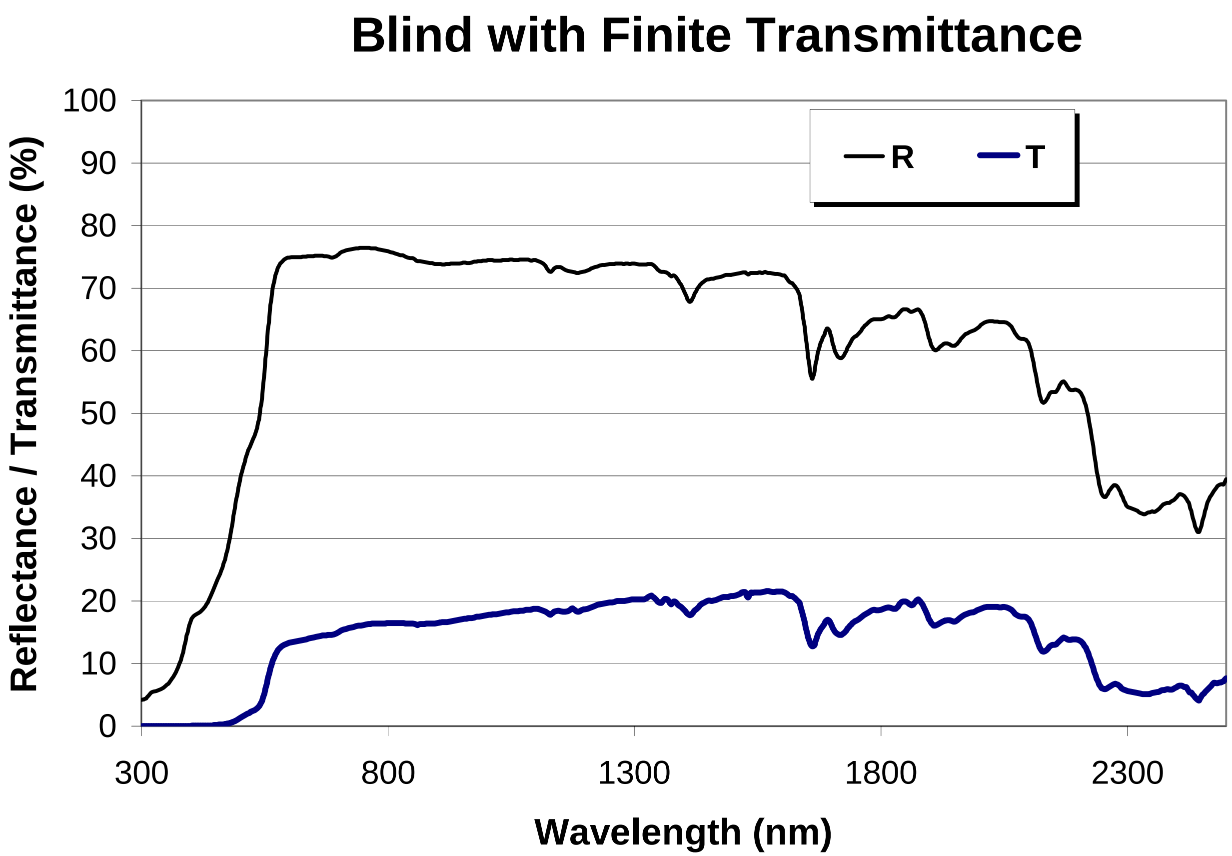
Spectral optical properties of blind materials Absorptive blinds



Spectral optical properties of blind materials Reflective blinds



Spectral optical properties of blind materials: Transmissive blinds



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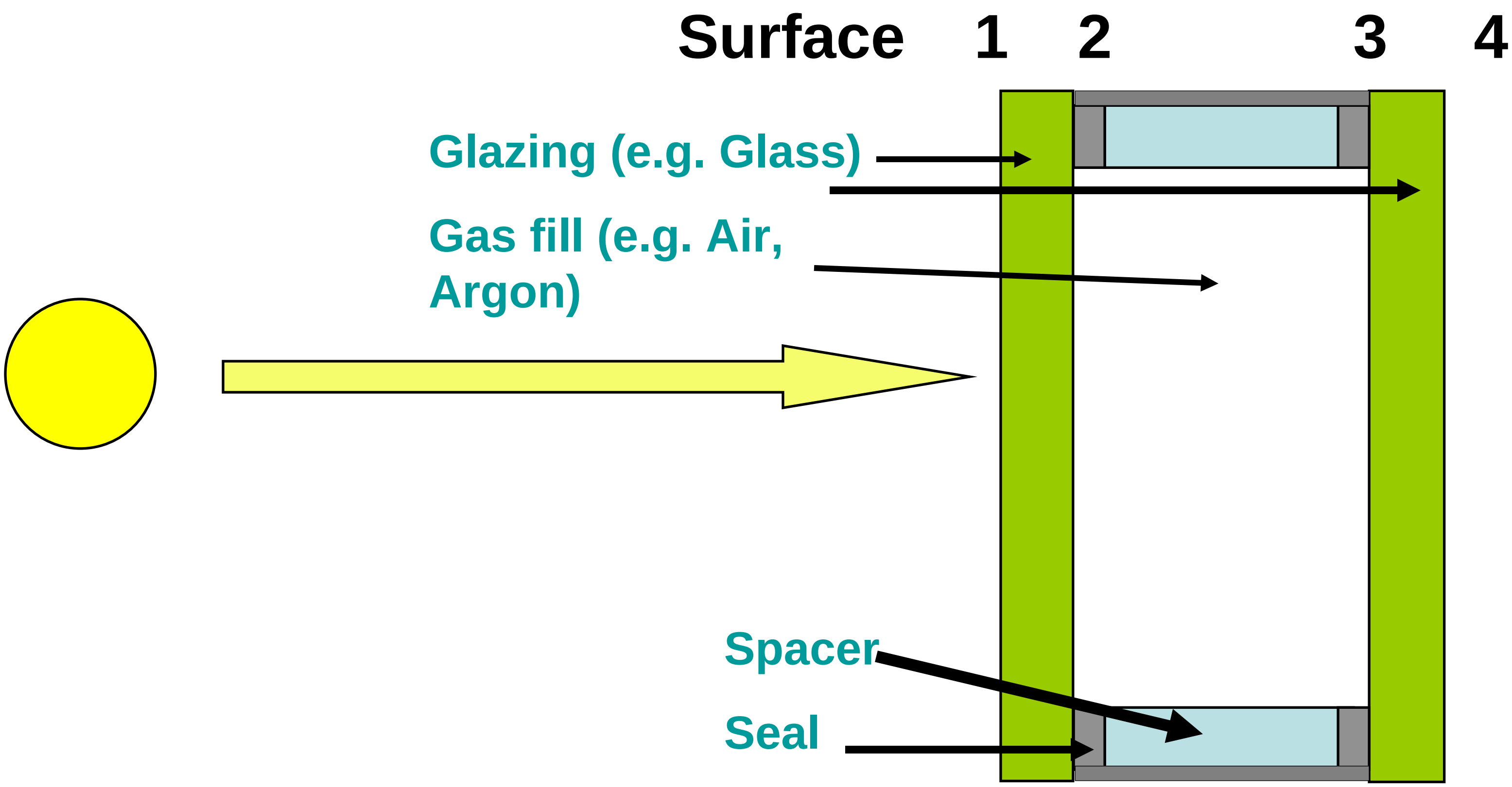
Frames and Spacers

Mostly used Frame Types

- Wooden Frame
- Plastic Frame
- Metall Frame
  - thermally broken profile
  - thermally unbroken profile
- Frames composed of Materialcombinations

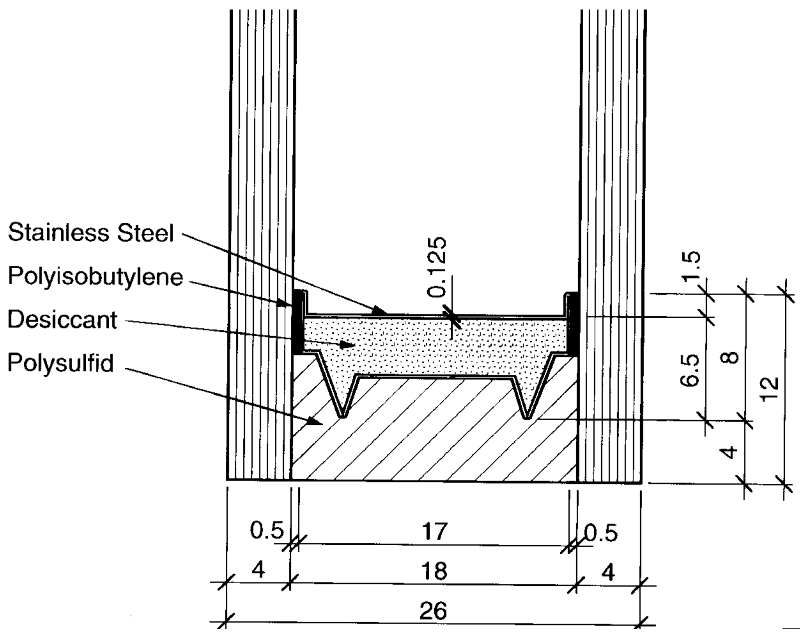
Glazing Schematic (ignoring the Frame)

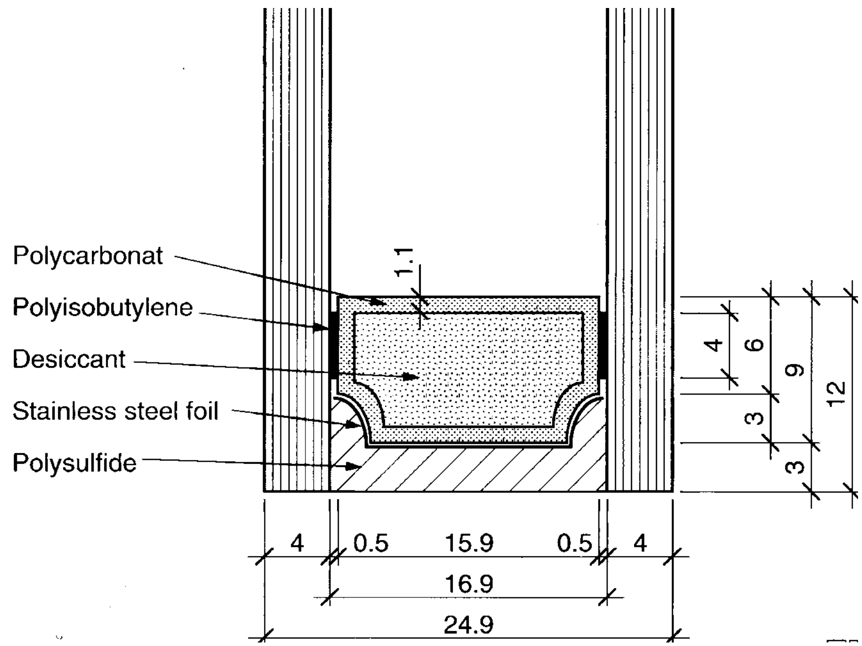


Categories of Spacer Types

- Aluminium Spacer
- Stainless Steel Spacer
- Synthetic Material Spacer
- Spacer of a combination of different Materials

Examples of Spacer





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Examples of Ψ-values of Spacers

for common types of glazing spacer bars **(e.g. aluminium or steel)**

Frame Type	Glazing type	
	Double or triple glazing uncoated glass air or gas filled	Double or triple glazing low emissivity glass (1 pane coated for double glazed) (2 panes coated for triple glazed) air or gas filled
Wood or PVC	0,06	0,08
Metal with a thermal break	0,08	0,11
Metal without a thermal break	0,02	0,05

Examples of Ψ-values of Spacers

for glazing spacer bars with **improved thermal performance**

Frame Type	Glazing type	
	Double or triple glazing uncoated glass air or gas filled	Double or triple glazing low emissivity glass (1 pane coated for double glazed) (2 panes coated for triple glazed) air or gas filled
Wood or PVC	0,05	0,06
Metal with a thermal break	0,06	0,08
Metal without a thermal break	0,01	0,04