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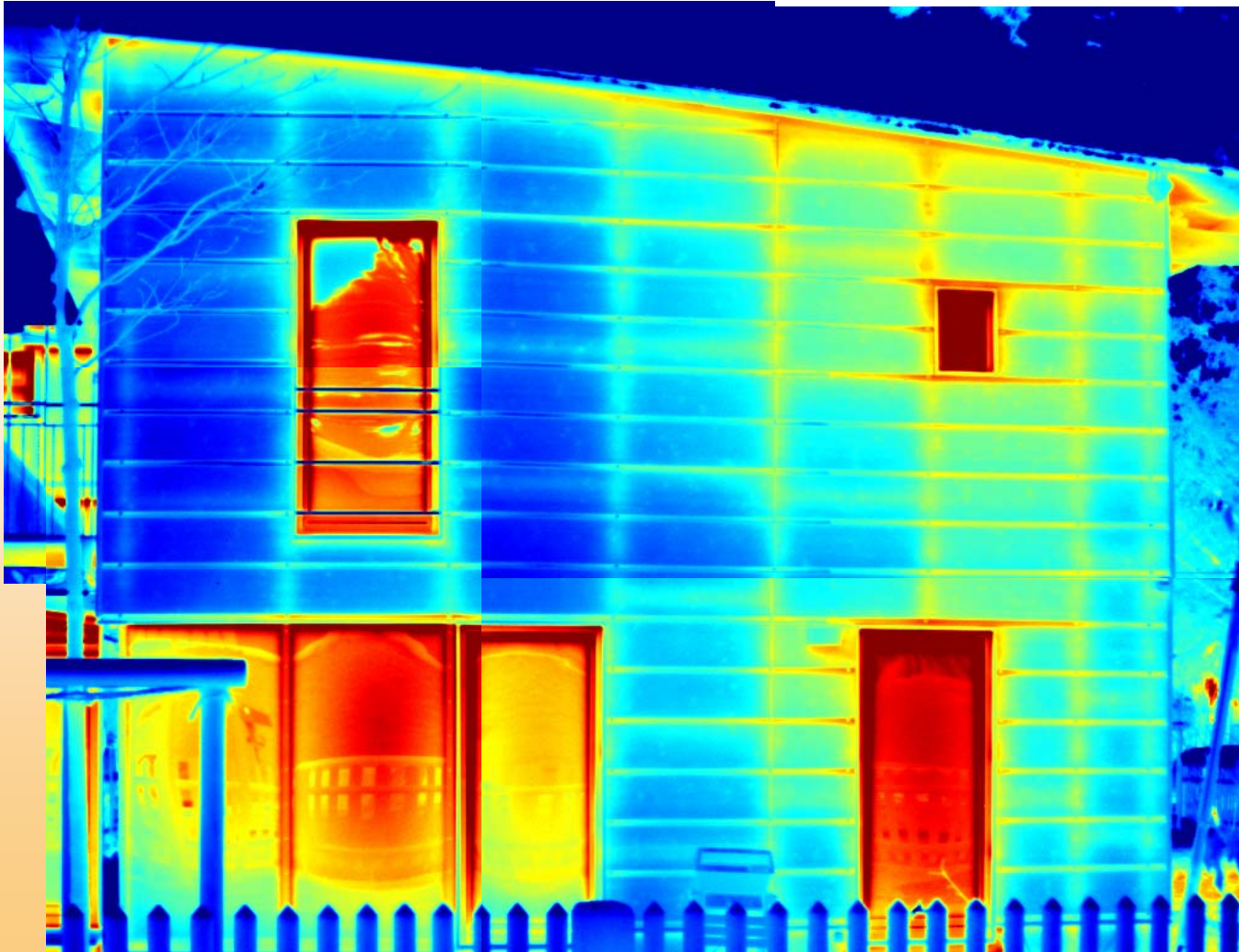
## VIG – Vacuum Insulation Glass

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Walls:

$$U = 0.15 \text{ W}/(\text{m}^2\text{K})$$



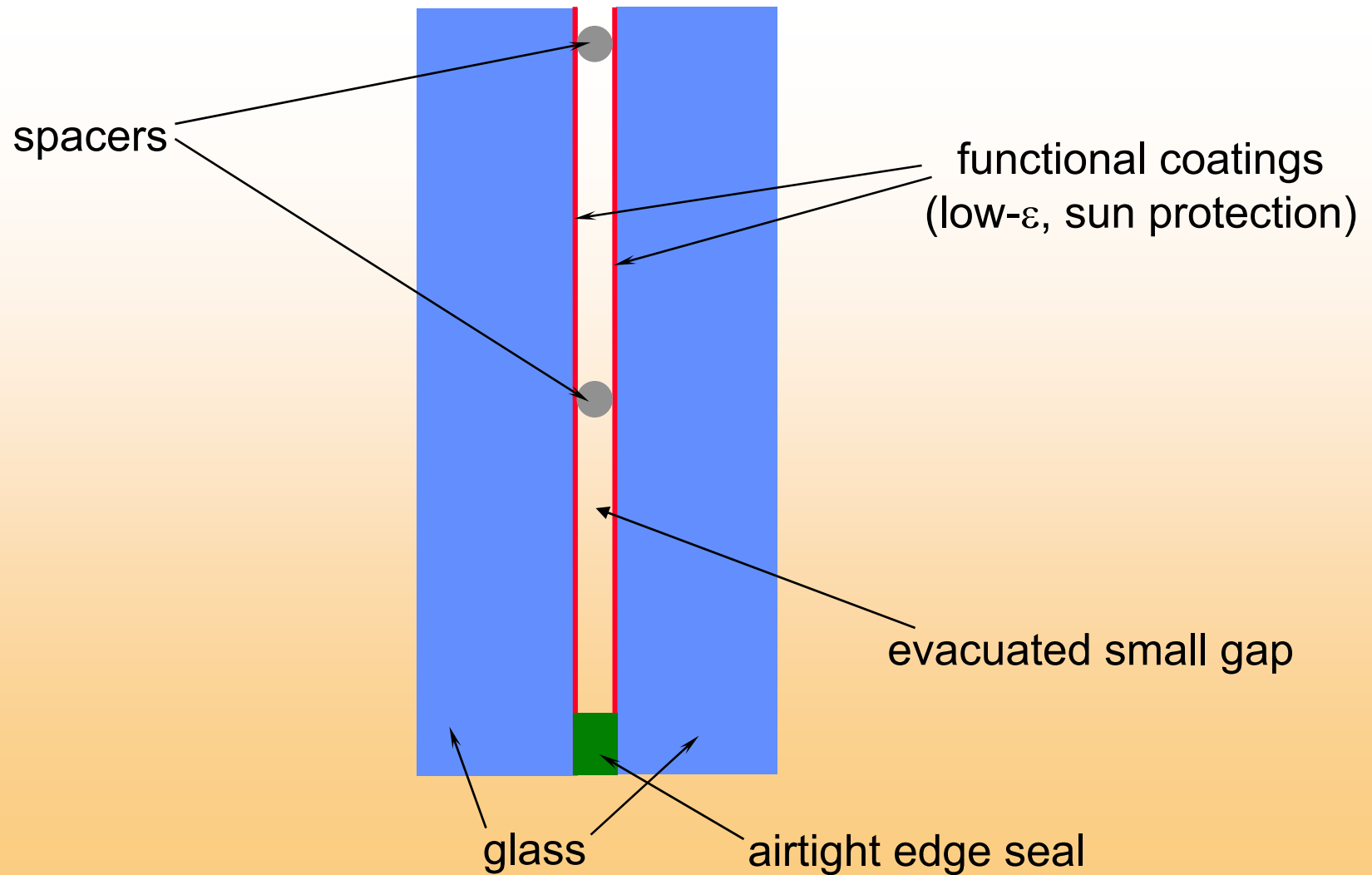
Windows:

$$U = 1.2 \text{ W}/(\text{m}^2\text{K})$$

(double glazing)

$$U = 0.8 \text{ W}/(\text{m}^2\text{K})$$

(triple glazing)



Qingdao Hengda Glass Group  
(China)

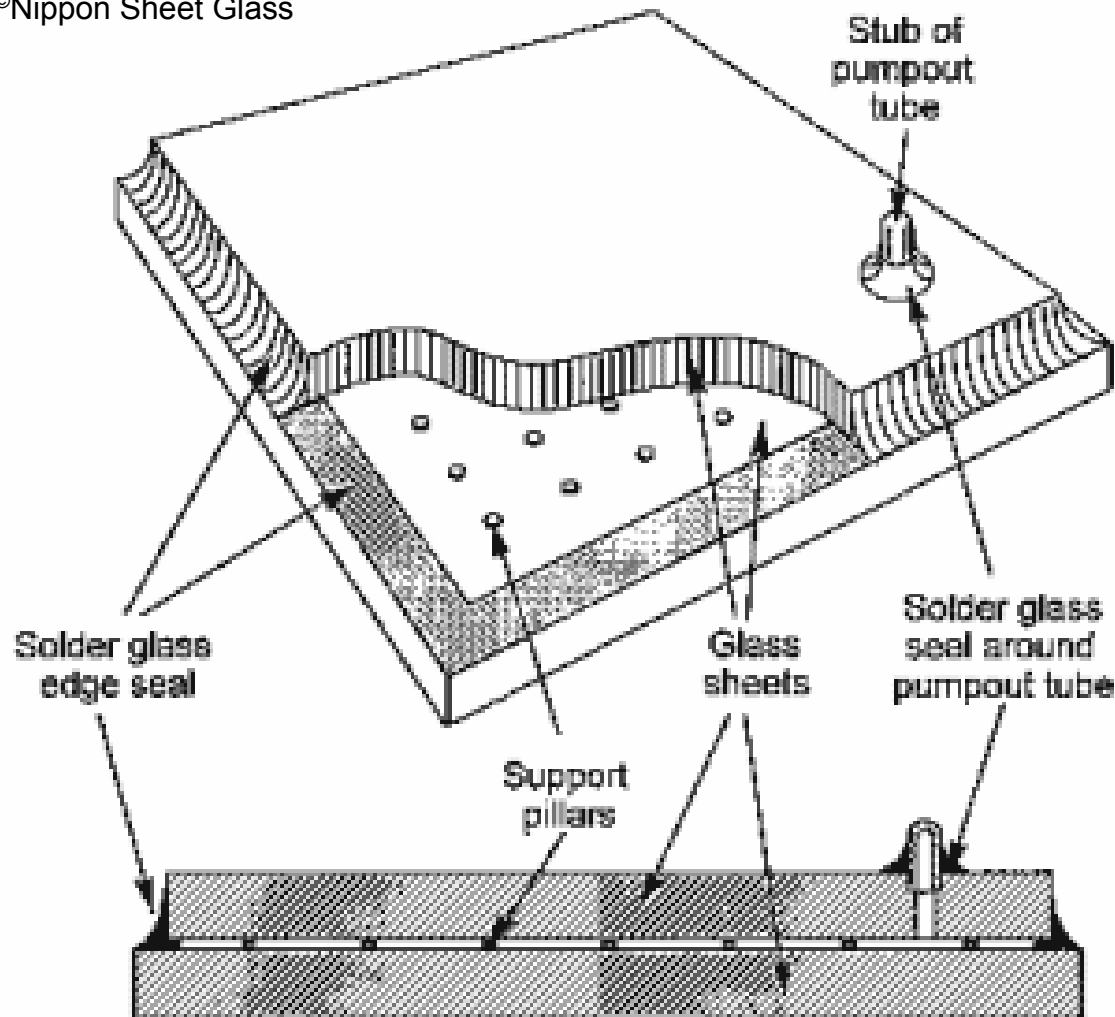
U-value:  $\geq 1.1 \text{ W}/(\text{m}^2\text{K})$

Nippon Sheet Glass Co., Ltd.  
(Japan)

U-value:  $\geq 1.2 \text{ W}/(\text{m}^2\text{K})$



©Nippon Sheet Glass



Major disadvantage:

high temperatures



only hardcoatings



U-values not low enough



# Research Project VIG



## German Research Project “VIG – Vacuum Insulation Glass”

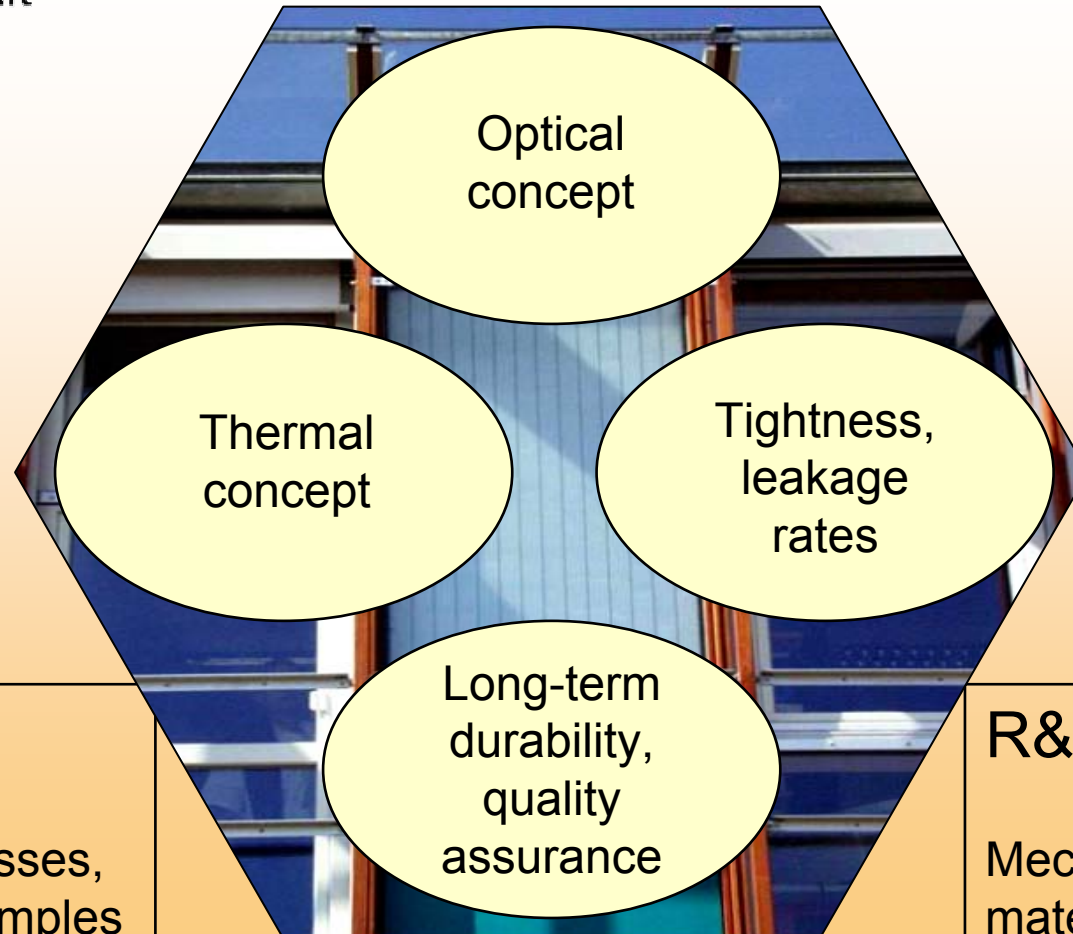
- development of Vacuum Insulation Glass (VIG) with  $U = 0.4 \text{ W}/(\text{m}^2\text{K})$
- thermal optimization (spacers, edge seal, low- $\epsilon$ -coatings)
- optical optimization (glare and visibility of spacers, transmission, g-value)
- edge seal concepts (glass-glass-joints, metal foils, high-barrier adhesives)
- development of production process for VIG
- production costs similar to triple glazing





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und Arbeit

ZAE Bayern:



Industry:

Production processes,  
specifications, samples

R&D:

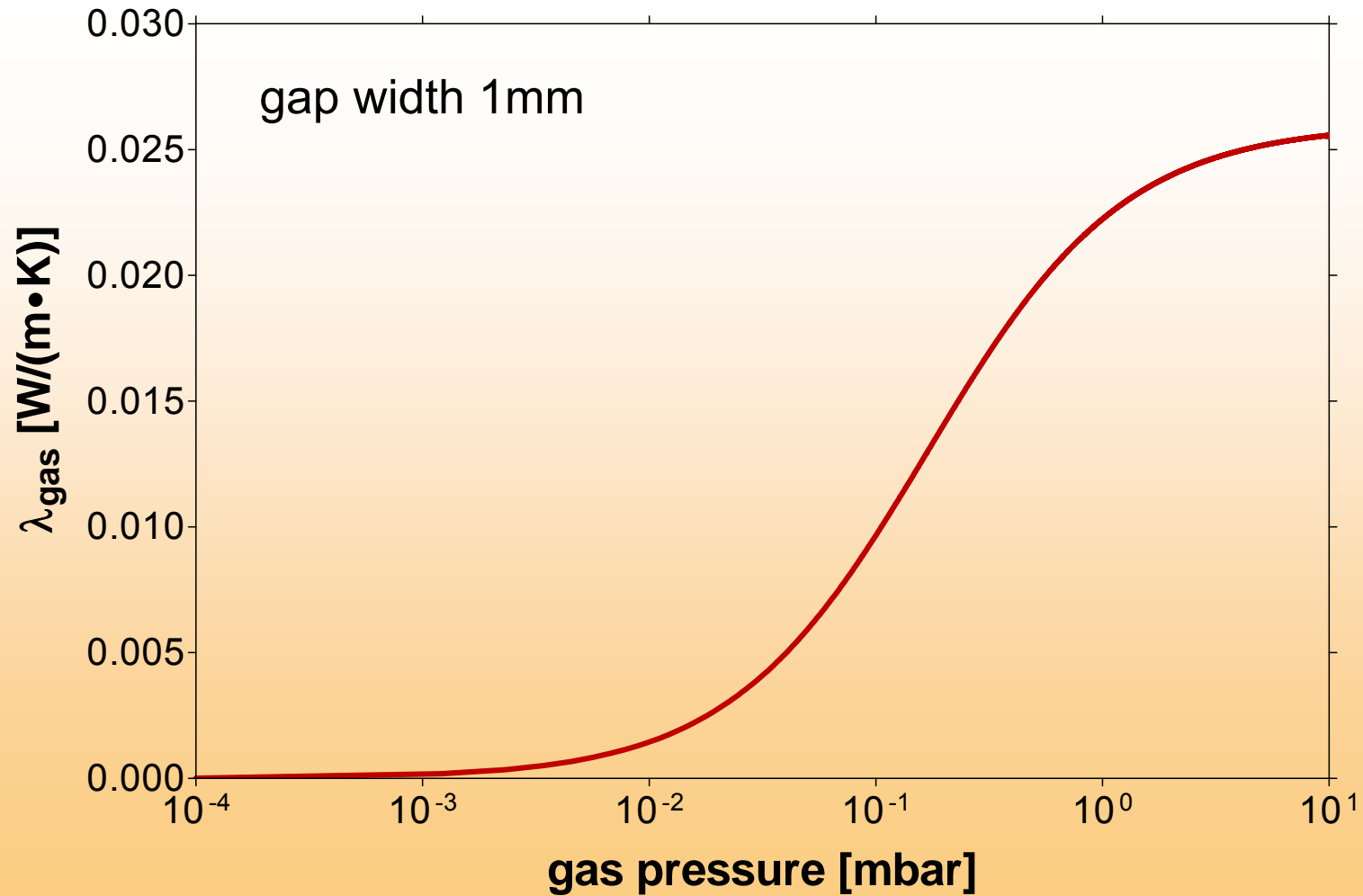
Mechanical stress,  
materials development

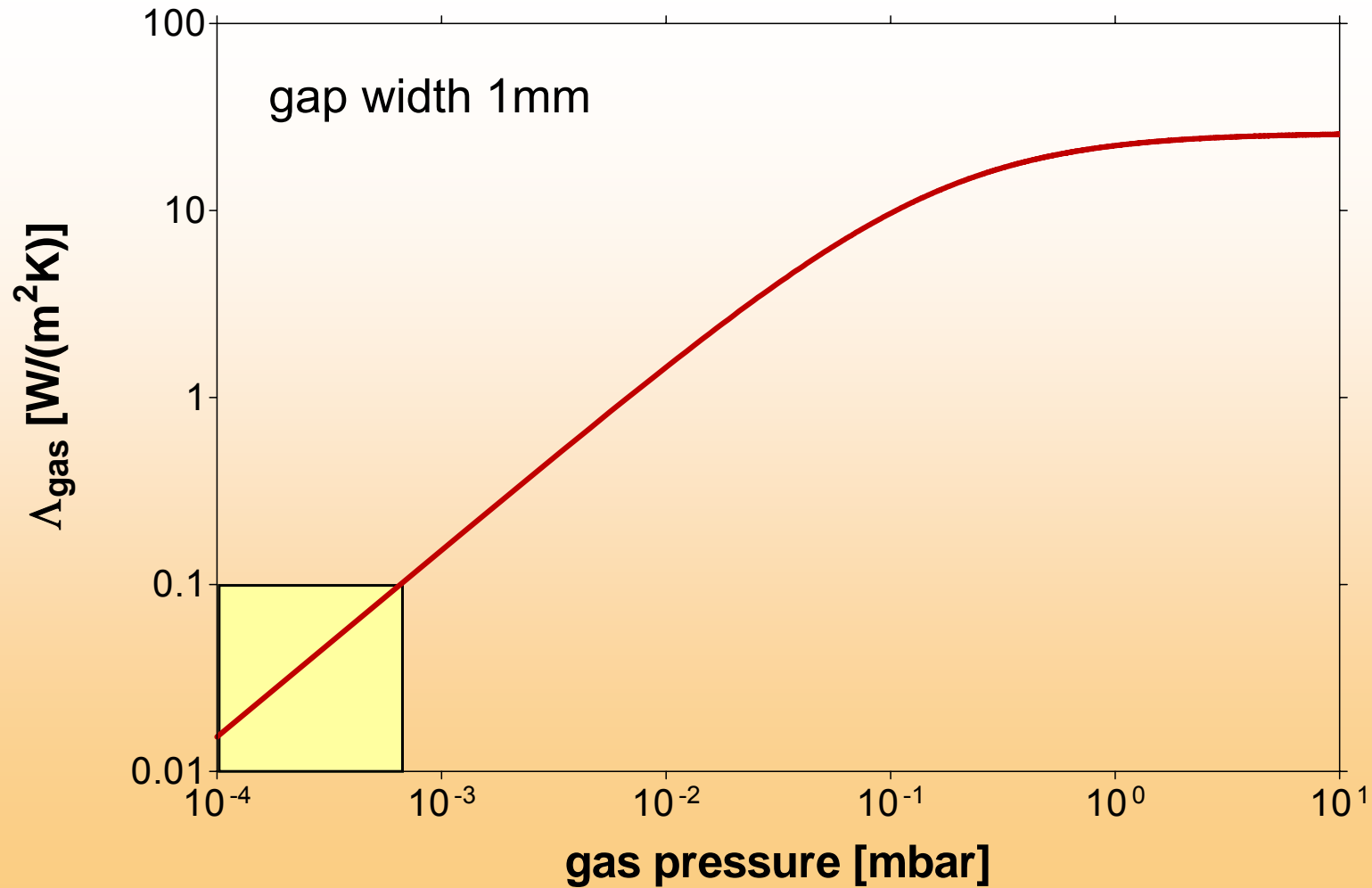
## Four distinct heat transfer mechanisms

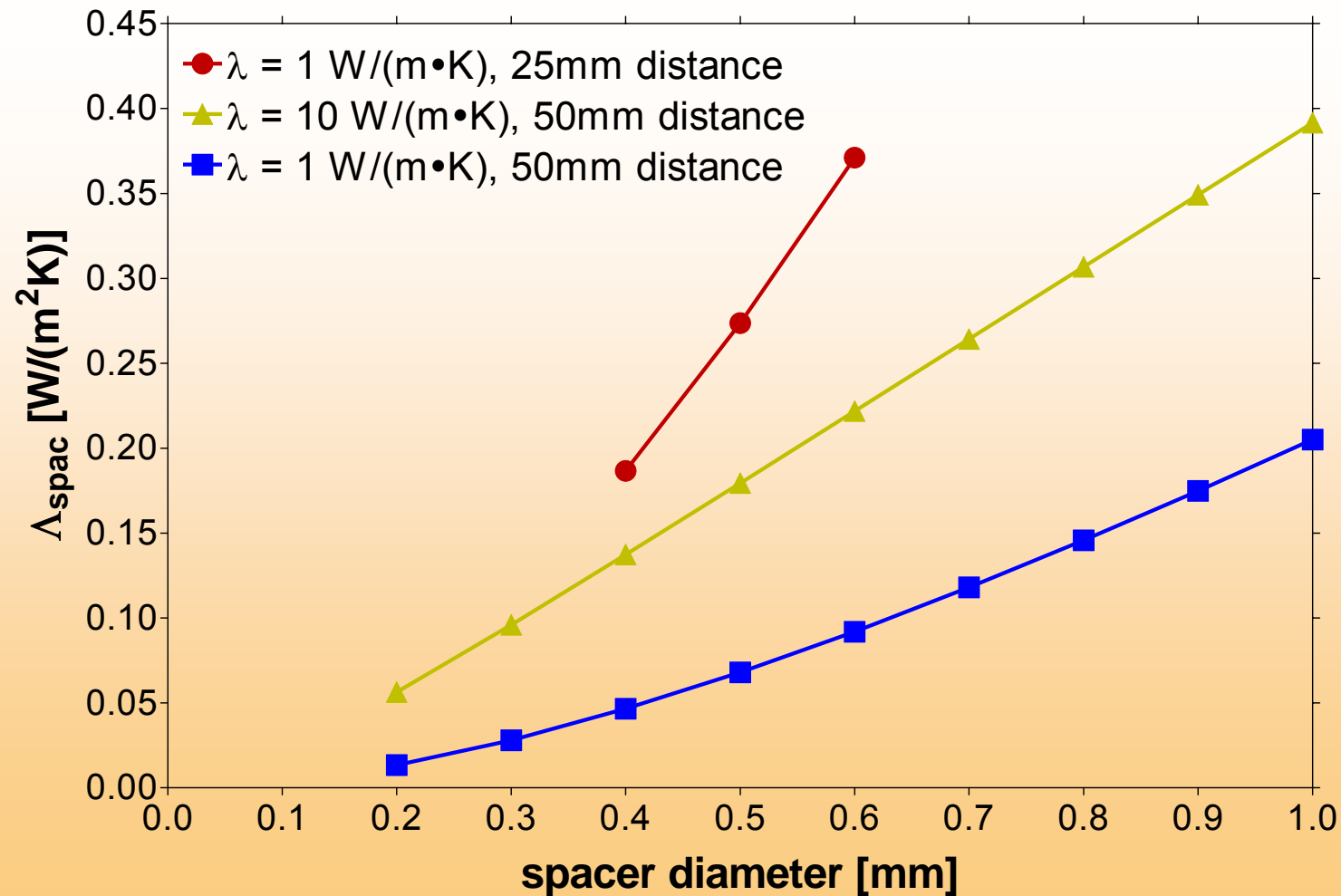
- thermal conduction through residual gas ( $\Lambda_{\text{gas}}$ )
- thermal conduction through spacers ( $\Lambda_{\text{spac}}$ )
- thermal conduction through edge seal ( $\Lambda_{\text{seal}}$ )
- thermal radiation heat transfer between glass panes ( $\Lambda_{\text{rad}}$ )

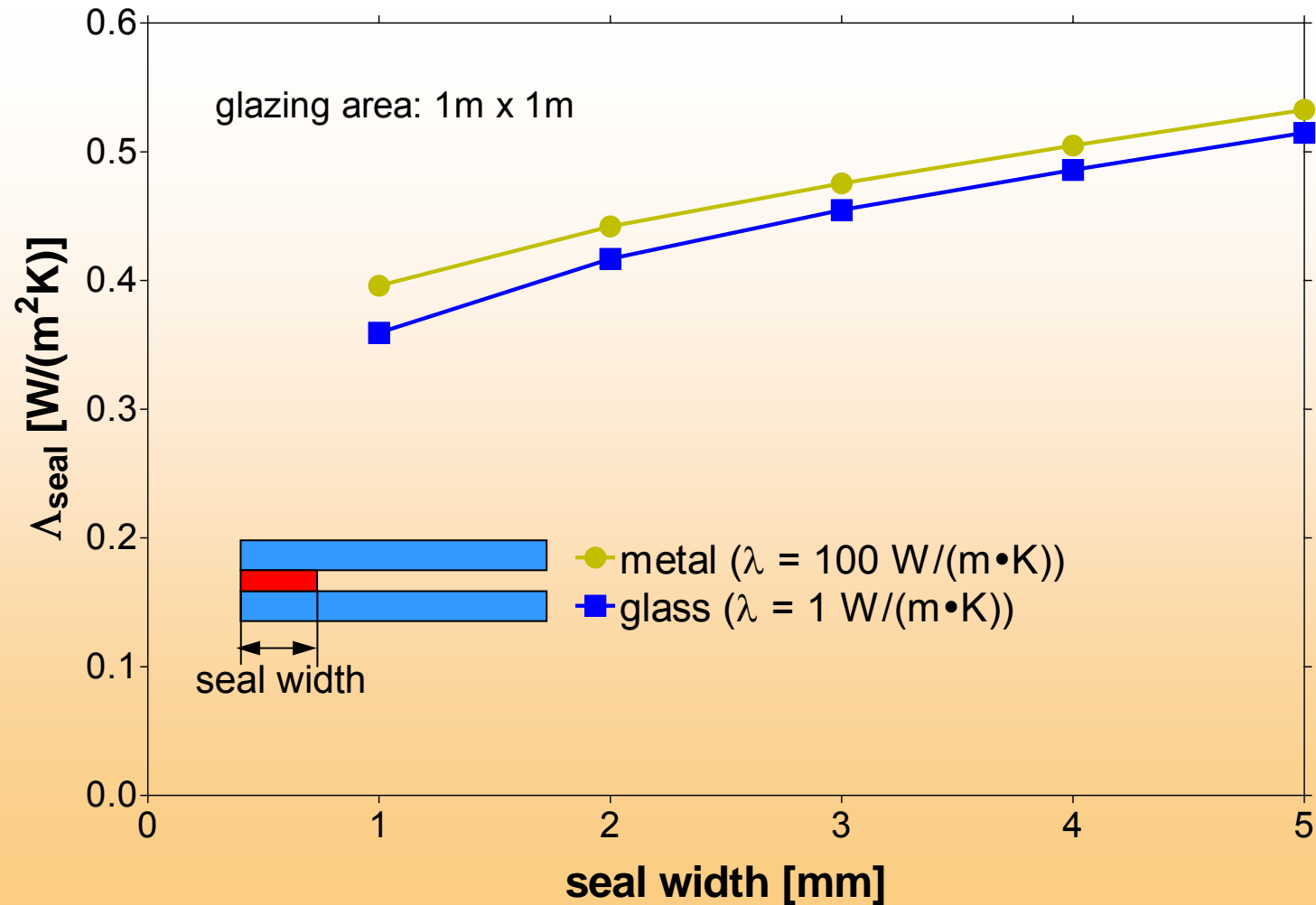
$$\Rightarrow \Lambda_{\text{tot}} \approx \Lambda_{\text{gas}} + \Lambda_{\text{spac}} + \Lambda_{\text{seal}} + \Lambda_{\text{rad}} \approx \text{U-value for } \Lambda_{\text{tot}} \leq 0.5 \text{ W}/(\text{m}^2\text{K})$$

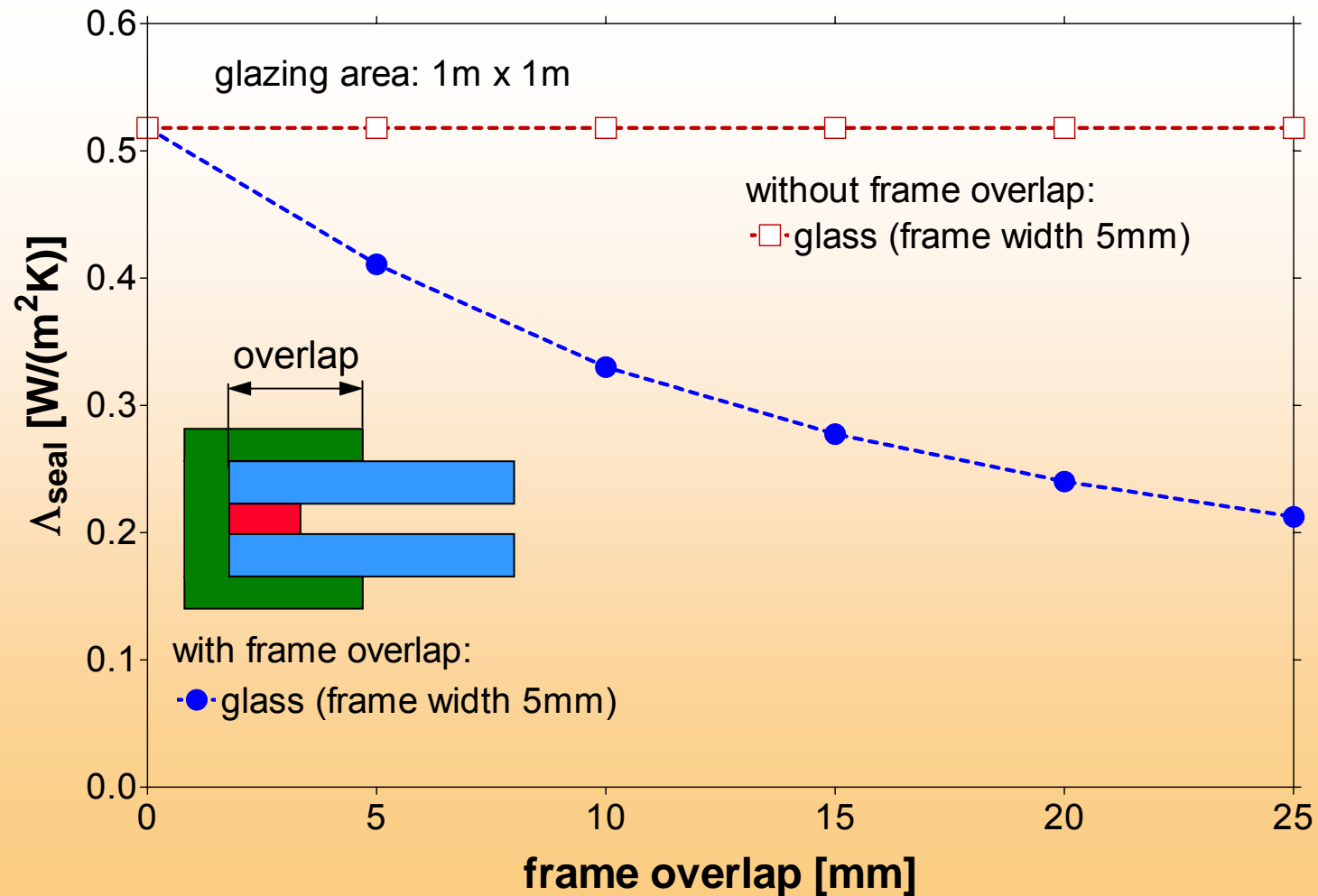


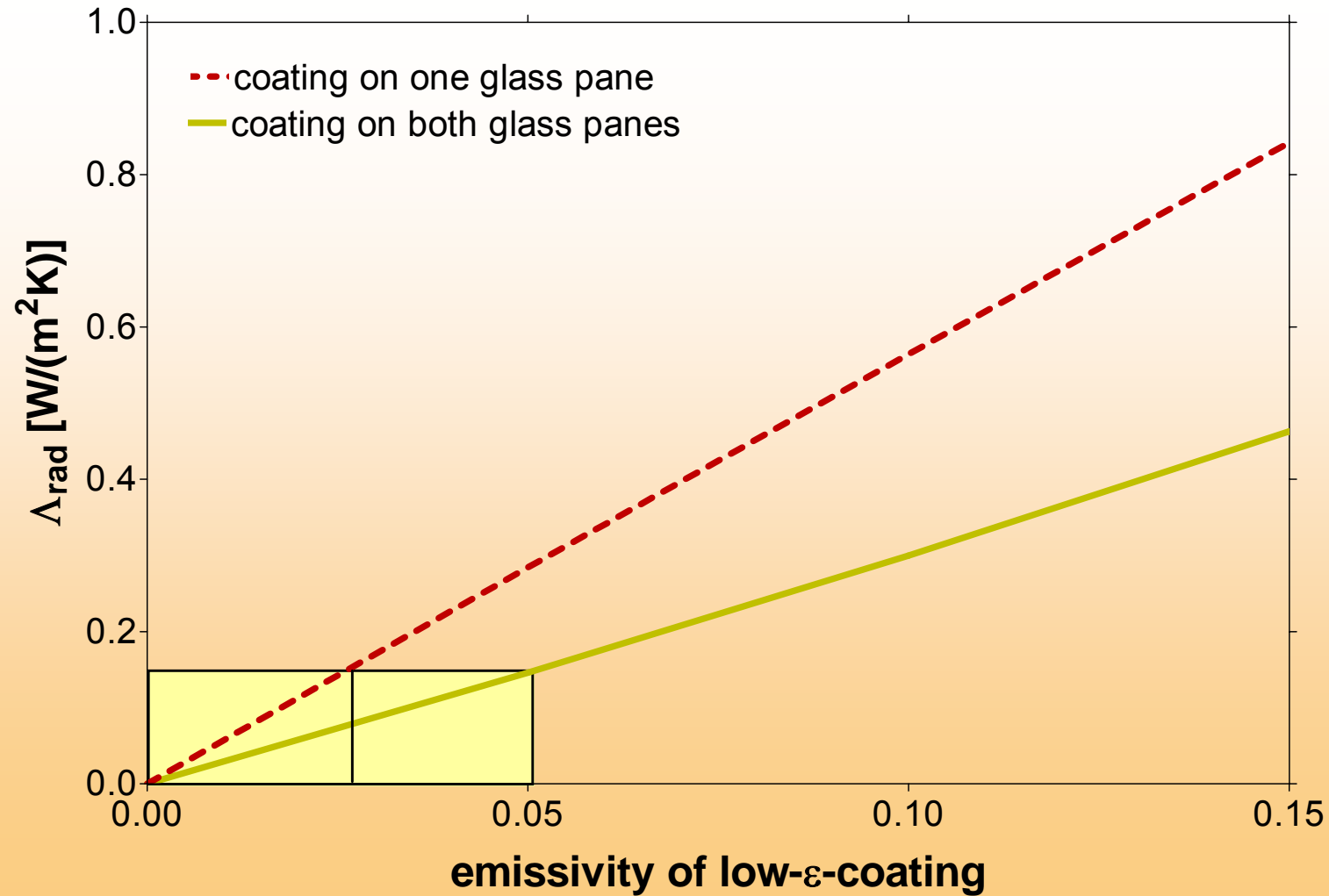












green:  
thermally optimized

red:  
typical values for  
commercial vacuum glazing

$\Lambda_{\text{gas}}$	0.02-0.2 W/(m <sup>2</sup> K)
$\Lambda_{\text{spac}}$	0.07-0.4 W/(m <sup>2</sup> K)
$\Lambda_{\text{seal}}$	0.2-0.7 W/(m <sup>2</sup> K)
$\Lambda_{\text{rad}}$	0.15-1.1 W/(m <sup>2</sup> K)
$\Lambda_{\text{tot}} = \Lambda_{\text{gas}} + \Lambda_{\text{spac}} + \Lambda_{\text{seal}} + \Lambda_{\text{rad}}$	0.44-2.4 W/(m <sup>2</sup> K)
<b>U-value (with seal and frame)</b>	<b>0.41-1.7 W/(m<sup>2</sup>K)</b>
<b>U-value (glazing only)</b>	<b>0.23-1.3 W/(m<sup>2</sup>K)</b>



Vacuum Insulation Glass (VIG) with  $U = 0.4 \text{ W}/(\text{m}^2\text{K})$  is possible if

- gas pressure  $\leq 10^{-4} \text{ mbar}$
- spacer distance  $\geq 50 \text{ mm}$  and spacer thermal conductivity  $\leq 1 \text{ W}/(\text{m}\cdot\text{K})$
- highly insulating frame with overlap of ca. 25 mm
- emissivity of low- $\varepsilon$ -coating  $\leq 0.03$  (one pane)  
 $\leq 0.05$  (both panes)

The project  
VIG – Vacuum Insulation Glass  
is supported by the  
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of Economics and Labor  
AZ: 032 7366A



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und Arbeit

Further information available on

[www.vig-info.de](http://www.vig-info.de)