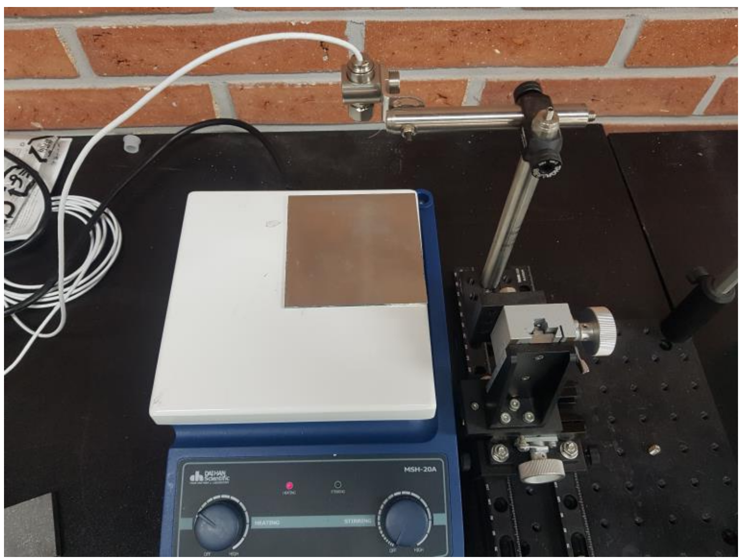
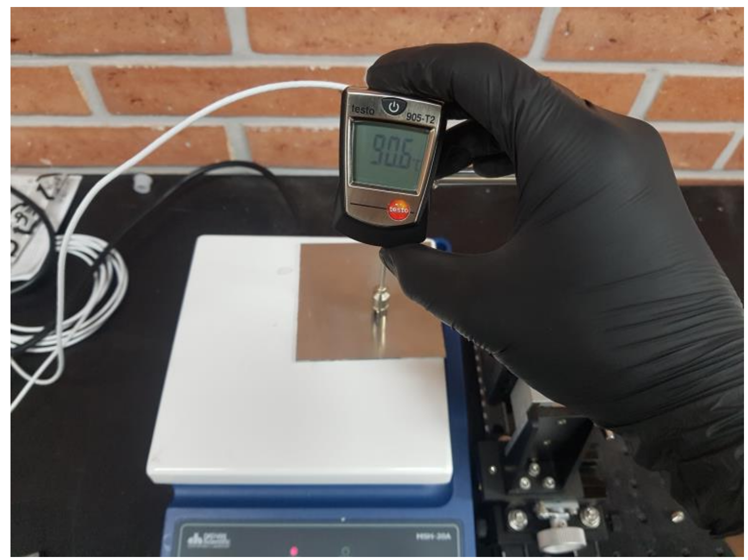
복사열전달 실험

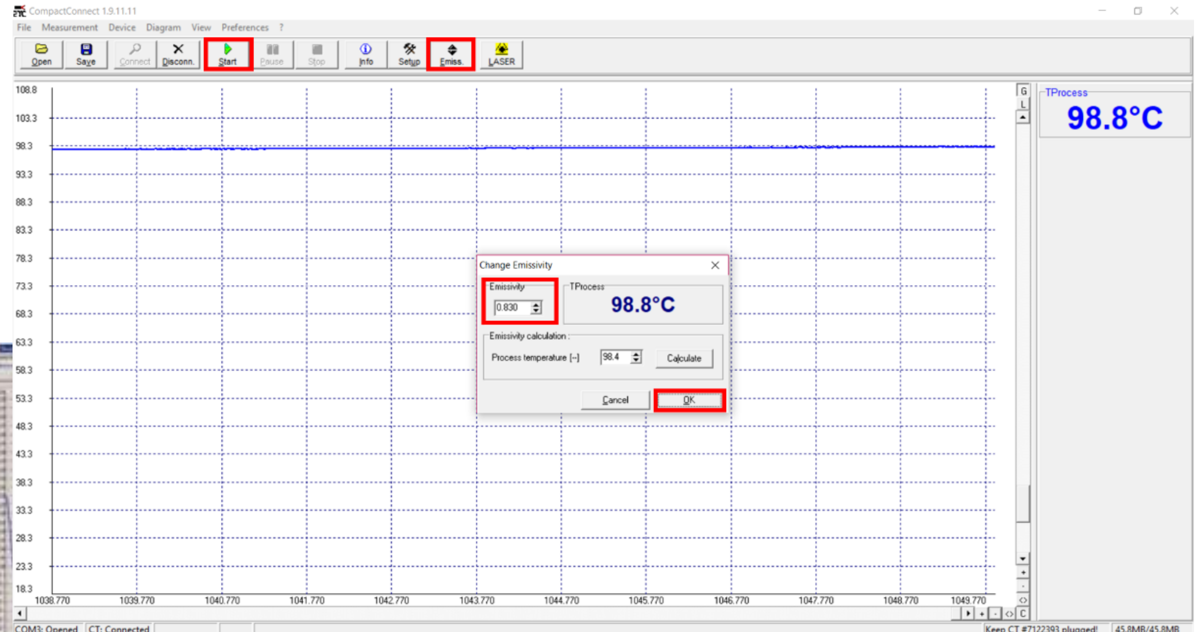
실험 개요

실험목적

- 이 실험의 목적은 가열된 플레이트 윗면의 emissivity를 실험을 통해 구하고, 이를 이용하여 플레이트의 온도 분포를 비접촉식 적외선 온도 센서를 이용하여 구하는 것을 목적으로 한다.



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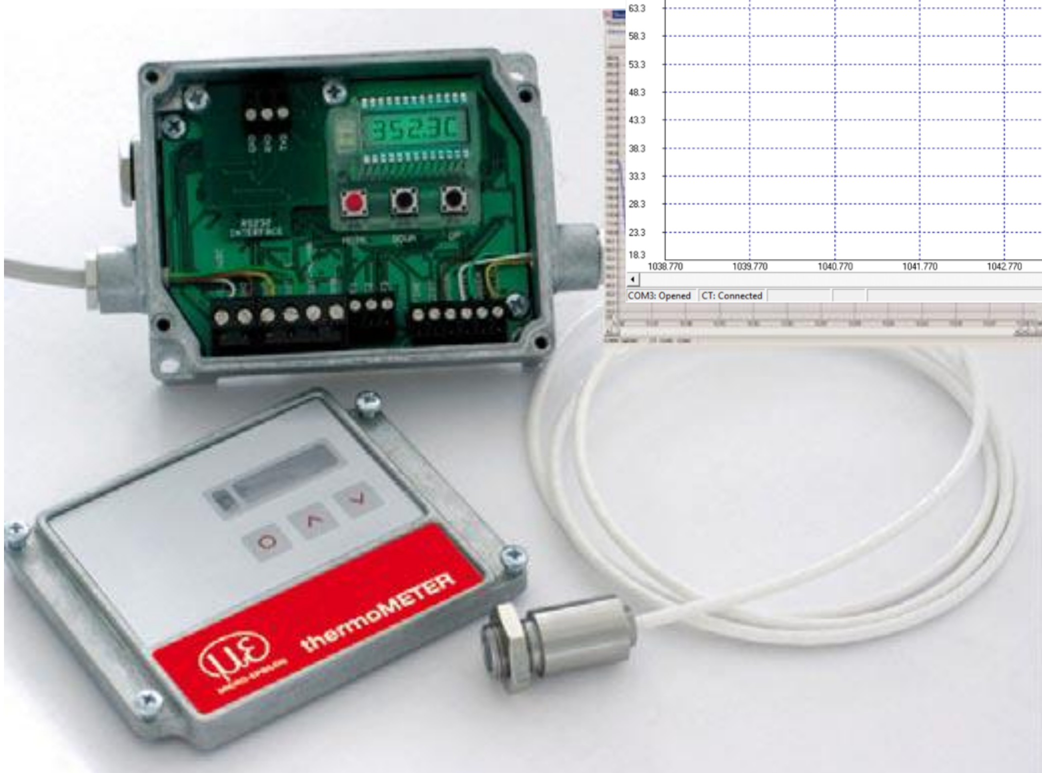
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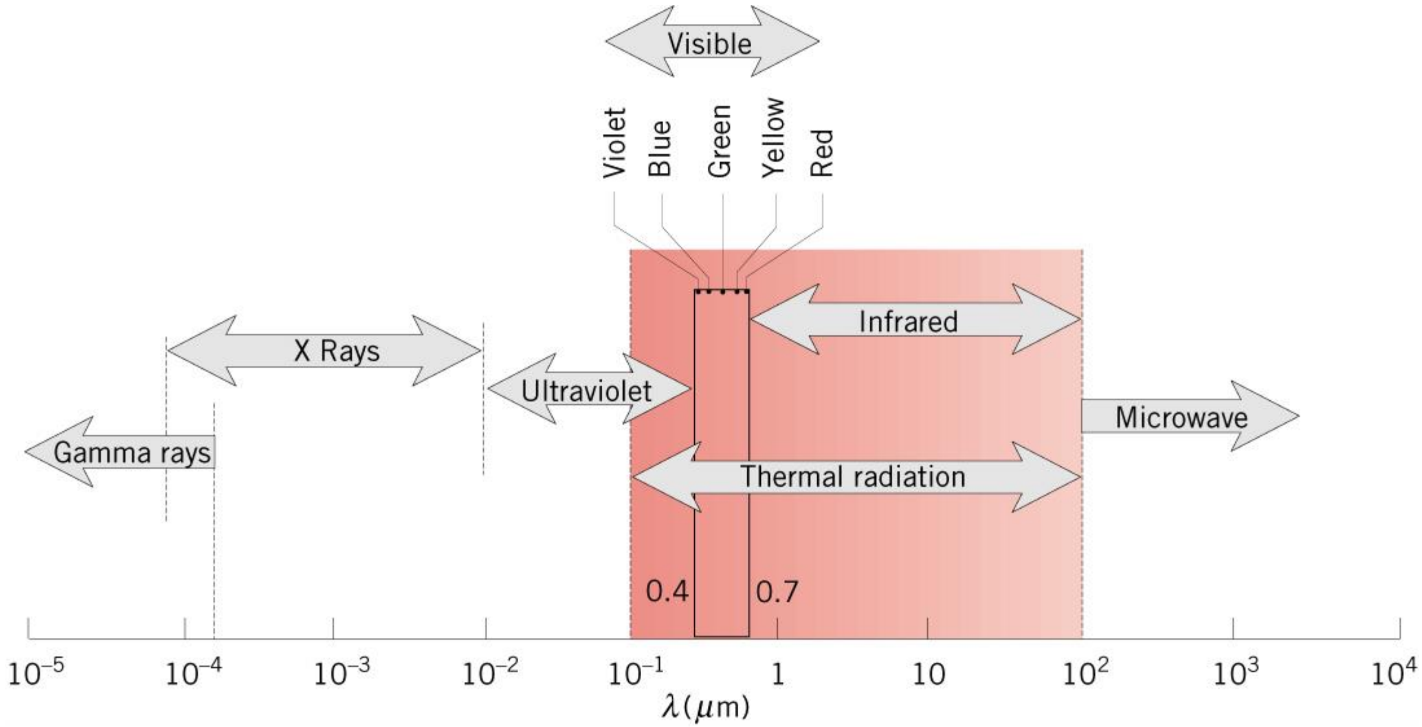
실험 이론



- Thermal radiation is confined to the infrared, visible and ultraviolet regions of the spectrum $\left(0.1 < \lambda < 100\mu\text{m}\right)$.

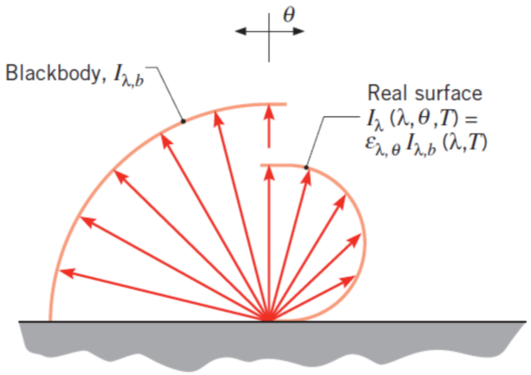
Surface Emissivity

- Radiation emitted by a surface may be determined by introducing a property (the emissivity) that contrasts its emission with the ideal behavior of a blackbody at the same temperature.

- The definition of the emissivity depends upon one's interest in resolving directional and/or spectral features of the emitted radiation, in contrast to averages over all directions (hemispherical) and/or wavelengths (total).

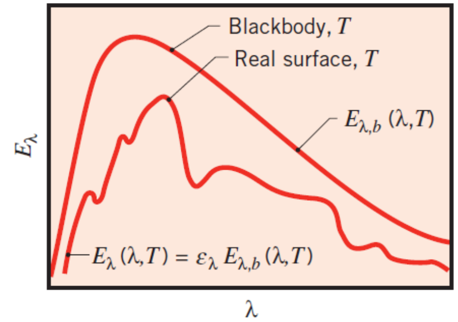
- The spectral, directional emissivity:

$$\varepsilon_{\lambda,\theta}(\lambda,\theta,\phi,T) \equiv \frac{I_{\lambda,e}(\lambda,\theta,\phi,T)}{I_{\lambda,b}(\lambda,T)}$$



- The spectral, hemispherical emissivity (a directional average):

$$\varepsilon_\lambda(\lambda,T) \equiv \frac{E_\lambda(\lambda,T)}{E_{\lambda,b}(\lambda,T)} = \frac{\int_0^{2\pi}\int_0^{\pi/2} I_{\lambda,e}(\lambda,\theta,\phi,T)\cos\theta\sin\theta d\theta d\phi}{\int_0^{2\pi}\int_0^{\pi/2} I_{\lambda,b}(\lambda,T)\cos\theta\sin\theta d\theta d\phi}$$



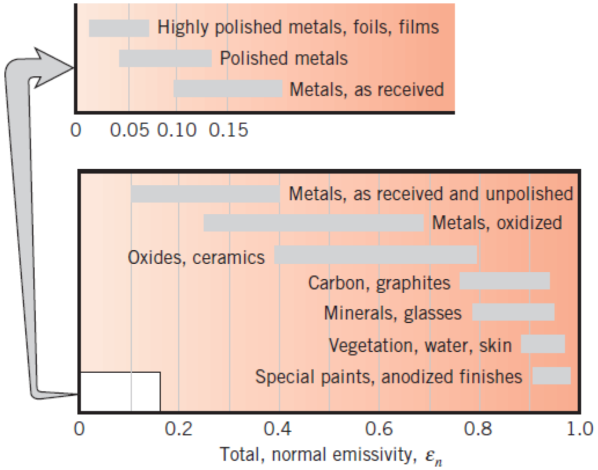
- The total, hemispherical emissivity (a directional and spectral average):

$$\varepsilon(T) \equiv \frac{E(T)}{E_b(T)} = \frac{\int_0^\infty \varepsilon_\lambda(\lambda,T) E_{\lambda,b}(\lambda,T) d,\lambda}{E_b(T)}$$

- To a reasonable approximation, the hemispherical emissivity is equal to the normal emissivity.

$$\varepsilon \approx \varepsilon_n$$

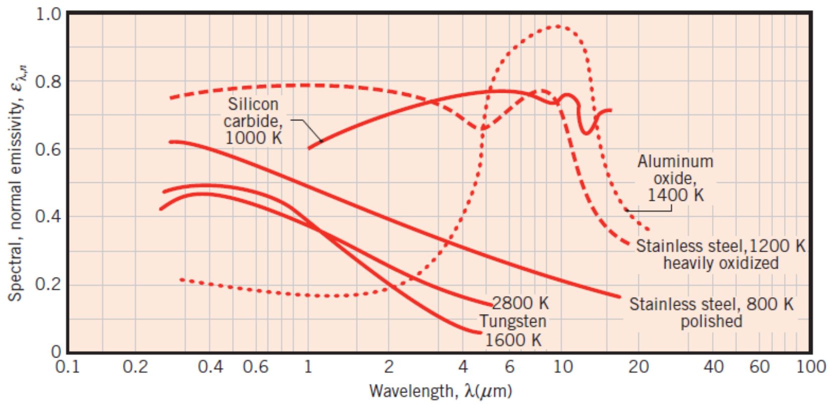
- Representative values of the total, normal emissivity:



Note:

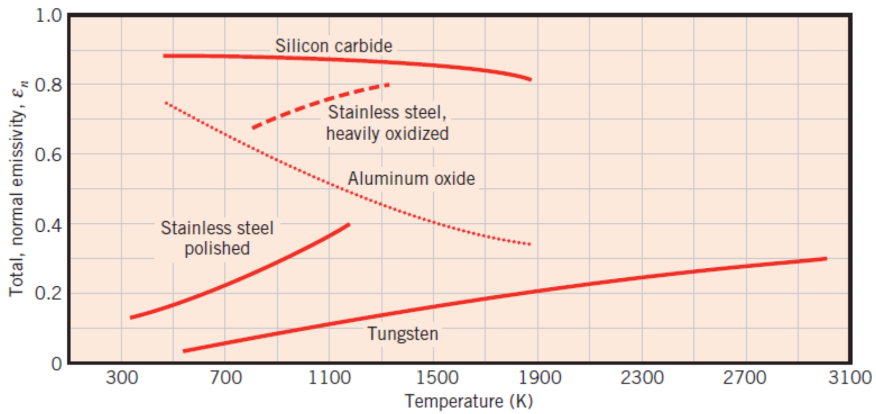
- Low emissivity of polished metals and increasing emissivity for unpolished and oxidized surfaces.
- Comparatively large emissivities of nonconductors.

- Representative spectral variations:



Note decreasing $\varepsilon_{\lambda,n}$ with increasing λ for metals and different behavior for nonmetals.

- Representative temperature variations:



Why does ε_n increase with increasing λ for tungsten and not for aluminum oxide?