

太陽光吸収率の入射角度依存性 全半球放射率の温度依存性 測定・推算・設計

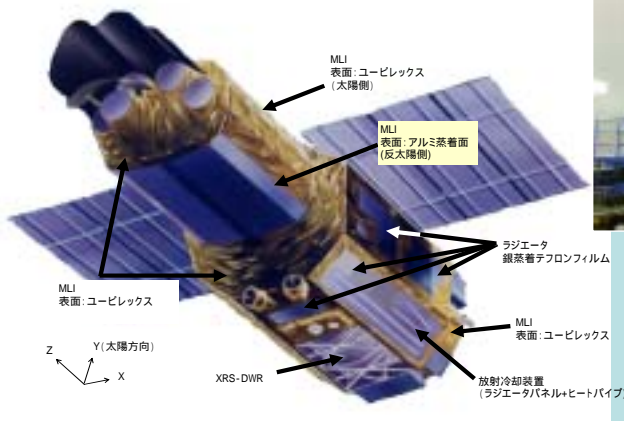
宇宙科学研究本部 / JAXA 大西 晃

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X線天文衛星

すざく 2005.7

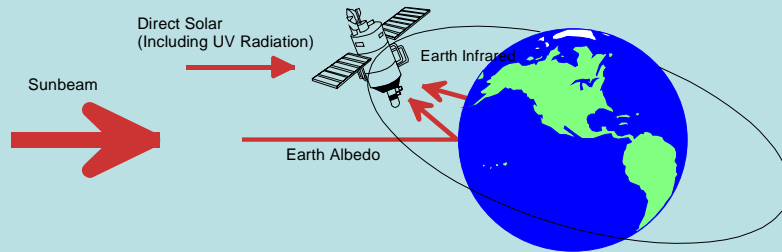
SUZAKU



- 重量 1.7ton
- 全高 6.5m
- 全幅 5.4m

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地球周りの熱環境



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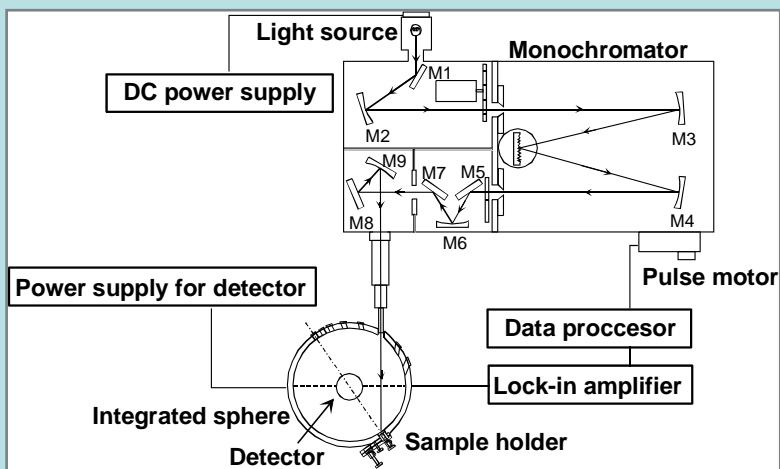
太陽光吸収率

$$\alpha_s(\theta) = \frac{\int_{0.26}^{2.5} \{1 - R_{ab}(\lambda, \theta)\} \cdot J_s(\lambda) d\lambda}{\int_{0.26}^{2.5} J_s(\lambda) d\lambda}$$

α_s	Solar absorptance
R	Spectral reflectance
J_s	Solar spectral irradiance
	Spectral
	Incidence angle

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分光透過率・反射率測定装置



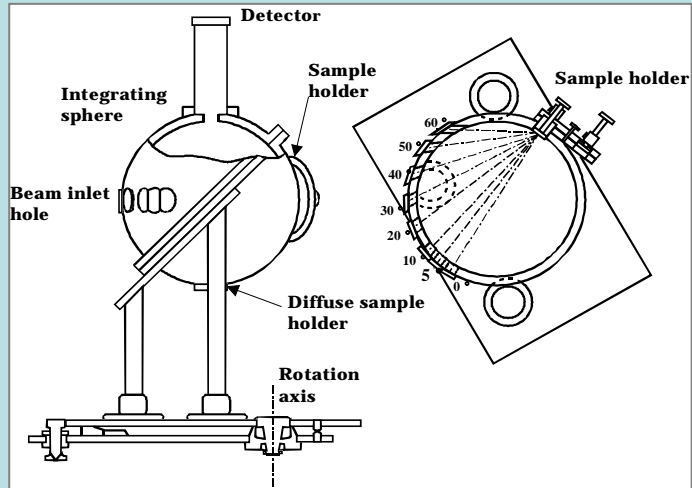
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分光透過率・反射率測定装置



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入射角可変積分球



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積分球

Diameter	300 mm
Incident Angle (deg)	0, 5, 10, 20, 30, 40, 50, 60
Inner Surface	Barium sulfate
Reference Sample	Spectralon(SRS-99)

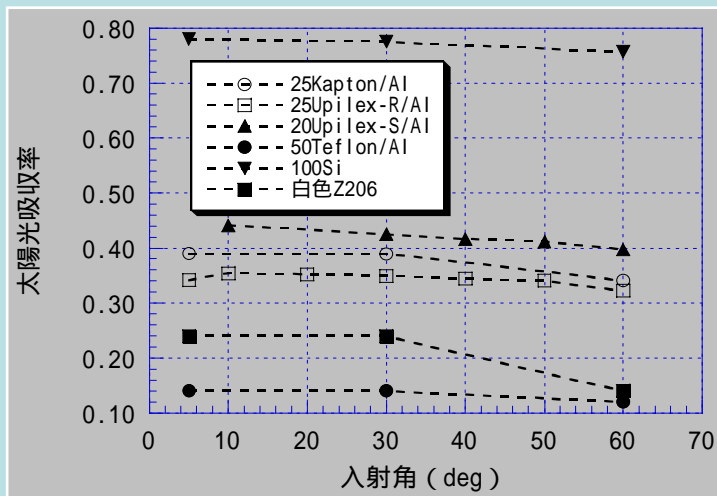
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システムデザイン

Wavelength Range	0.26 ~ 2.50 μm
Detectors	
-Photo multipliers	0.26 ~ 1.20 μm
-PbS	1.20 ~ 2.50 μm
Overall Uncertainty	$\pm 2.0 \sim 3.0 \%$

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太陽光吸収率入射角度依存性

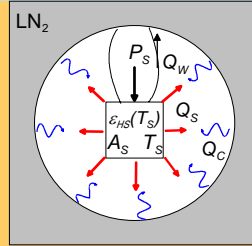


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全半球放射率

$$\epsilon_{HS}(T_S) = \frac{P - Q_W}{\sigma \cdot A_S (T_S^4 - T_W^4)} - \frac{A_{Al}}{A_S} \cdot \epsilon_{HAL}(T_S)$$

P_S	Input power
Q_W	Lead wires heat loss
T_S	Sample temperature
T_W	Inner surface temperature
A_S	Sample surface area

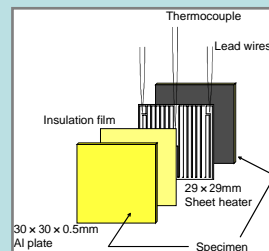
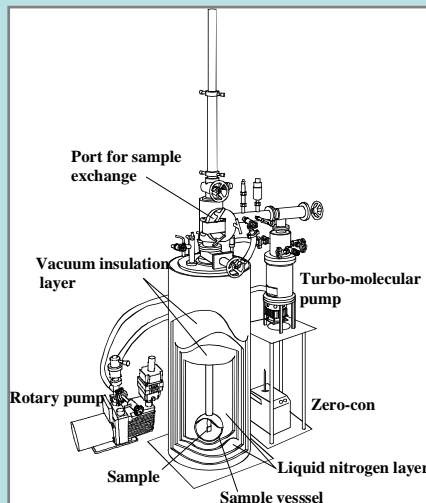


- P_S : Power input to the sample
- Q_S : Energy radiated from the sample
- Q_C : Energy radiated from the inner surface of the enclosure
- Q_W : Heat loss of the sample through lead wires (including Joule's heat of lead wires)

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全半球放射率測定装置

173-700K



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全半球放射率測定装置

173-700K



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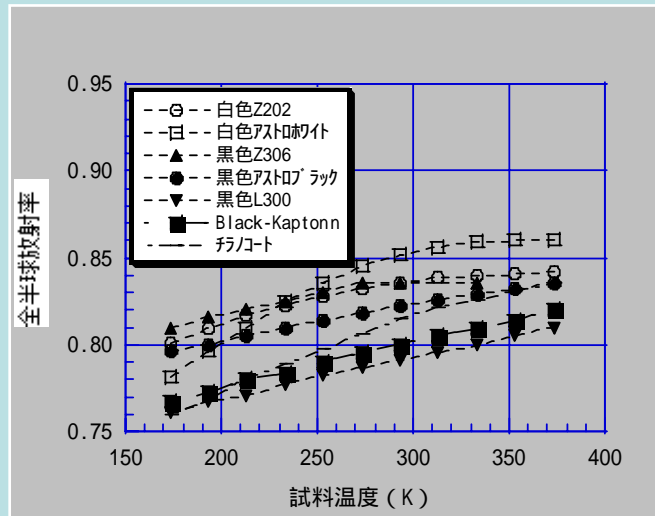
システムデザイン

Temperature Range	173 ~ 700 K
Measurement Room	Copper
Inside Diameter	250 mm
Inside Face	Black paint
Overall Uncertainty	$\pm 2.0 \sim 3.0 \%$

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全半球放射率

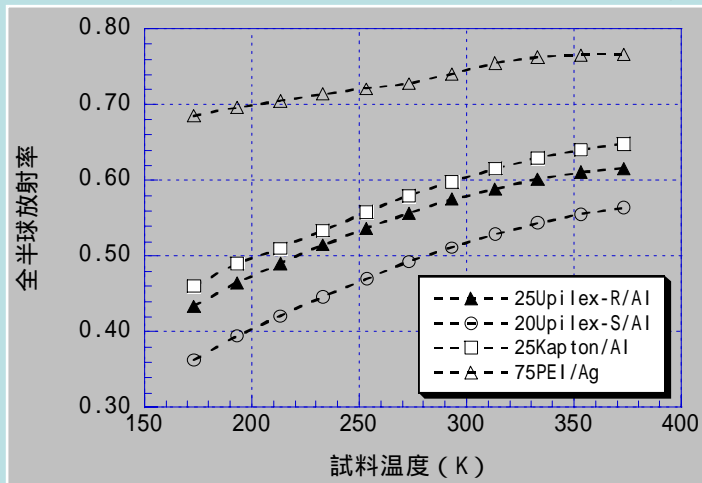
塗料類



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全半球放射率

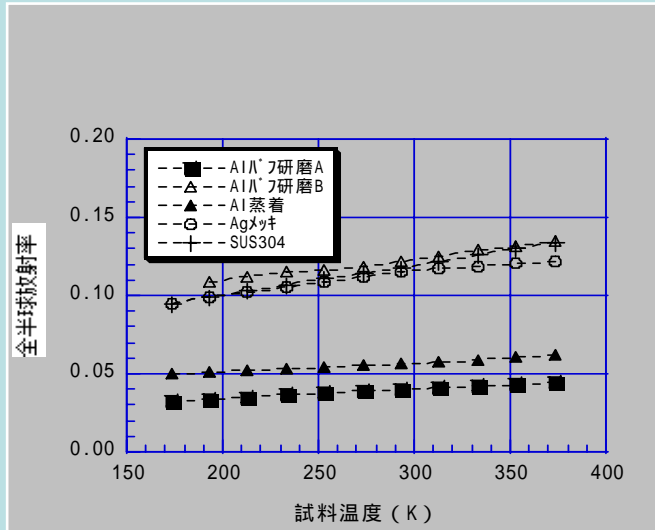
高分子フィルム



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全半球放射率

金属類



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分光法による 放射率の算出

波長範囲 : 1.0 ~ 100 μm

温度範囲 : 173 ~ 373K



$$\varepsilon_H(T) = \frac{\int_0^{\pi/2} \int_{0.25}^{100} \{1 - R(\lambda, \theta)\} \cdot i_b(\lambda, T) \cos \theta \sin \theta \, d\lambda \, d\theta}{\int_0^{\pi/2} \int_{0.25}^{100} i_b(\lambda, T) \cos \theta \sin \theta \, d\lambda \, d\theta}$$

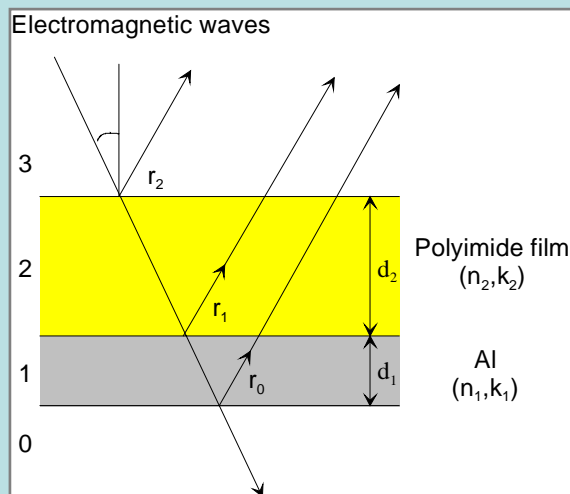
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太陽光吸収率・全半球放射率 推 算

- 測定装置の健全性
- 熱制御材料の設計評価

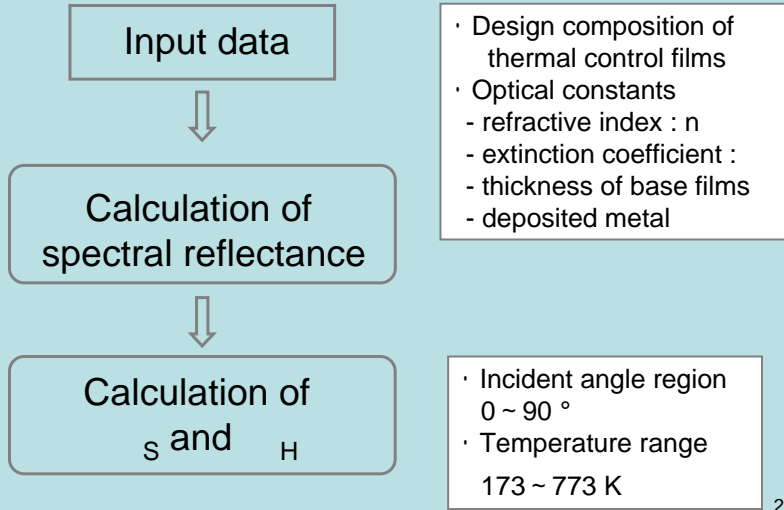
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推 算 例



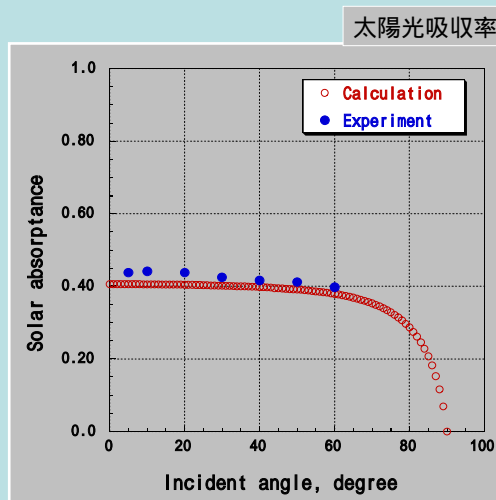
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推算フロー



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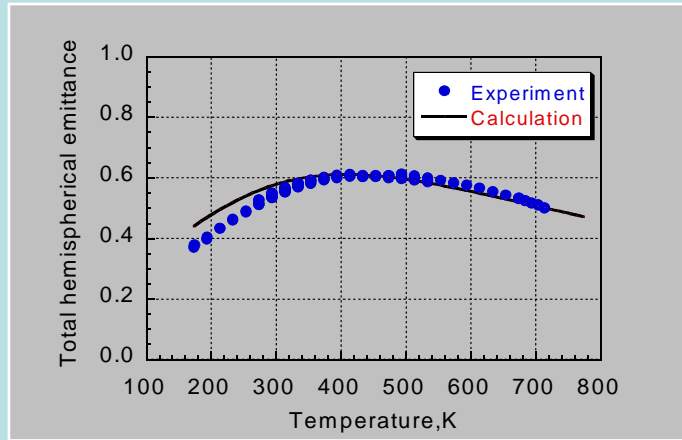
推算結果



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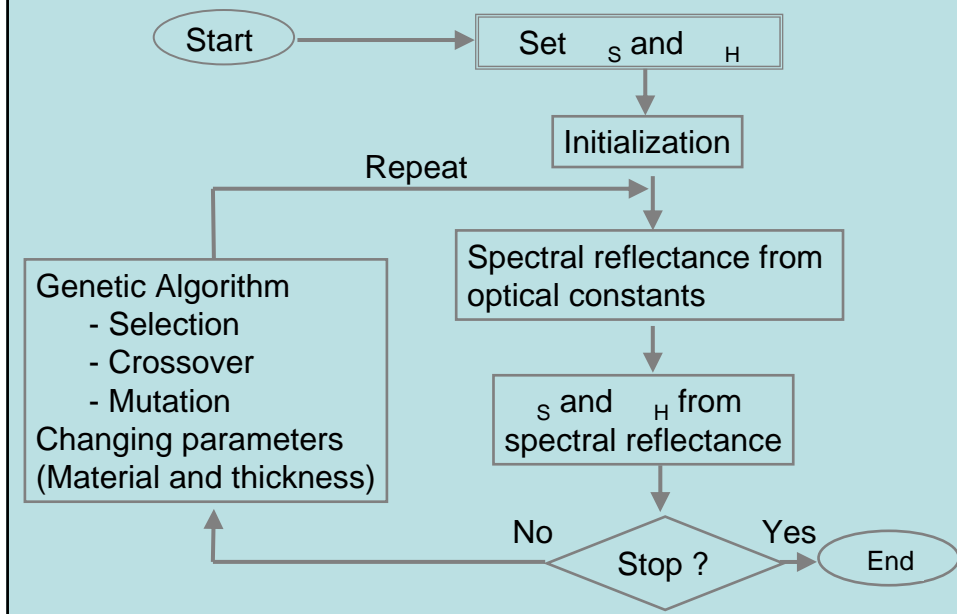
推算結果

全半球放射率



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多層薄膜の設計



設計パラメータ

Population	20
Generation	5000
Tournament Selection +Elite Preserving Selection	
Tournament Size	4
One-point Crossover	
Probability of Crossover	0.8
Probability of Mutation	0.1
Candidate Materials	a-Si, CaF ₂ , Ge, LiF, MgF ₂ , SiO ₂ , ZnS, ZnSe
Range of Thickness	0 ~ 300 nm
Maximum Number of layer	10
Target s	0.20
Target H	0.40

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可変放射率素子



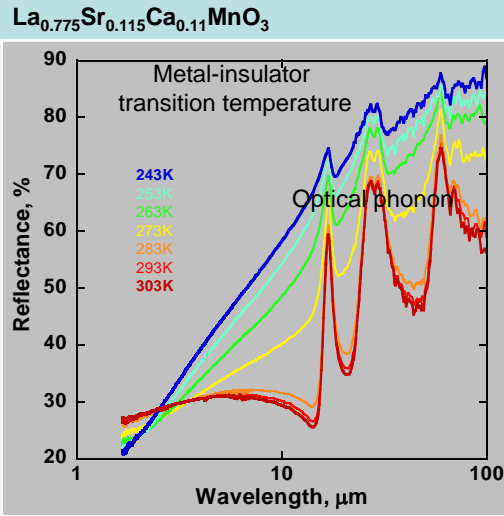
	Composition
Type1	La _{0.825} Sr _{0.175} MnO ₃
Type2	La _{0.7} Ca _{0.3} MnO ₃
Type3	La _{0.775} Sr _{0.115} Ca _{0.11} MnO ₃

Size : 40mm × 40mm × 170μm

Weight : 1.2 g/piece

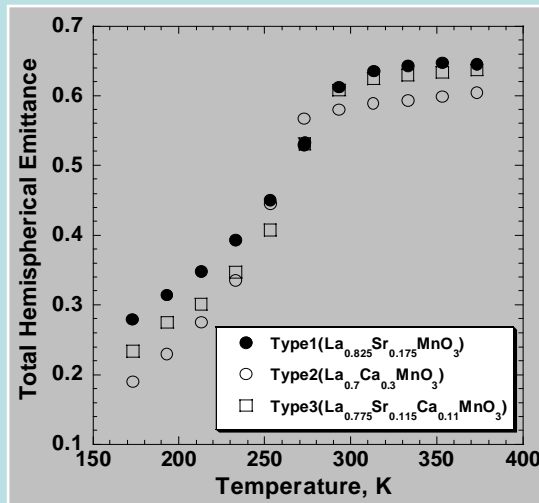
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分光反射率温度依存性



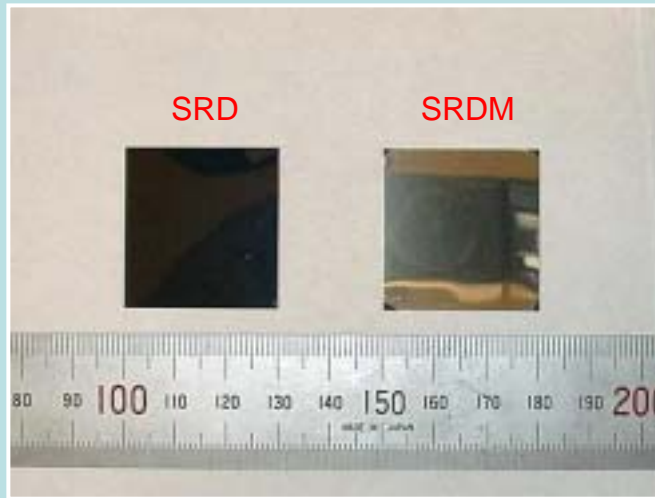
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全半球放射率



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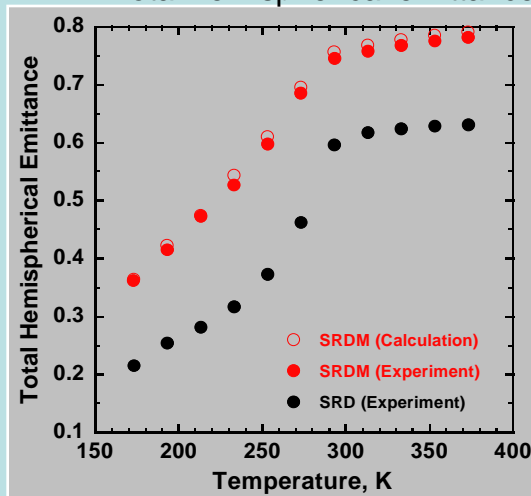
多層薄膜付SRD



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設計結果

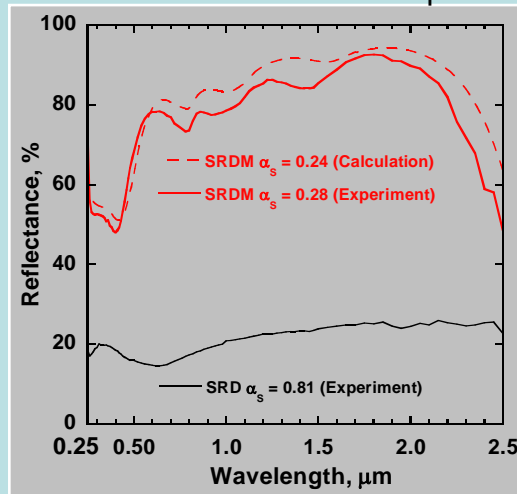
Total hemispherical emittance



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設計結果

Solar absorptance



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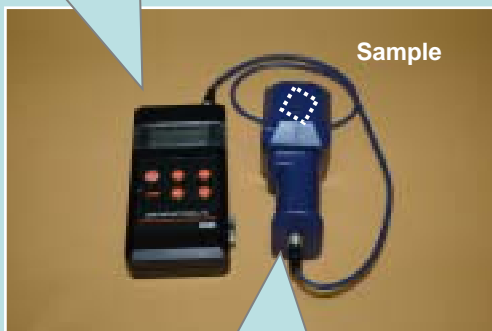
ポータブル測定装置

太陽光級数率・全半球放射率

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ポータブル放射率測定装置

Operating Unit
172.5 × 88.5 × 61 mm, 590g



Temperature Control Unit
with 3 Thermo-Sensors

Blackbody furnace
360 ± 0.5 K

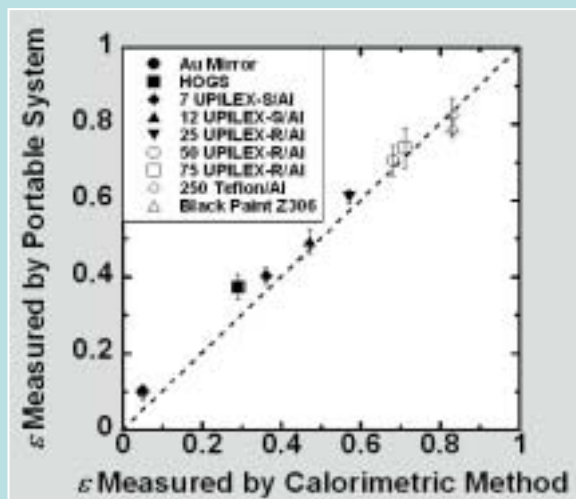
Sample/Reference
Temperature Dependence
Room

Measuring Time: < 10 sec

Measurement Unit
196 × 100 × 40 mm, 390g

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測定結果



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ホタル太陽光吸収率測定装置

0.26 ~ 2.6 μm

