HL 12.4

Surface-heat-emittance optimisation of CIS-based flexible solar cells

UNIVERSITÄT LEIPZIG

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Our Message

$CuInSe_2$ based flexible thin film solar cells on polyimide substrates are possible alternatives for crystalline silicon or GaAs based solar cells in space applications due to their low weight. Still their feasibility has to be proven. In order to achieve high specific power (W/kg), important optimization parameters parameters are, for instance, efficiency and surface heat emittance.

Introduction

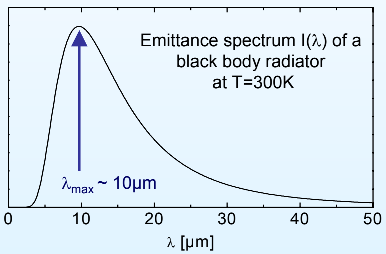
No transmission => **spectral emittance** $E(\lambda) = 1 - R(\lambda)$

(Integrated) Emissivity

$$E = \frac{\int [(1-R(\lambda))\cdot I(\lambda)] d\lambda}{\int I(\lambda) d\lambda}$$

R ... Reflectivity at angle of incidence 0°

I ... Intensity of the blackbody radiator at 300K



Procedure

1. Reflectivity at normal incidence from 0.2 to 40 μm is simulated by model calculations using model dielectric functions
2. Emissivity is calculated
3. Upon variation of parameters maximum of emissivity is determined

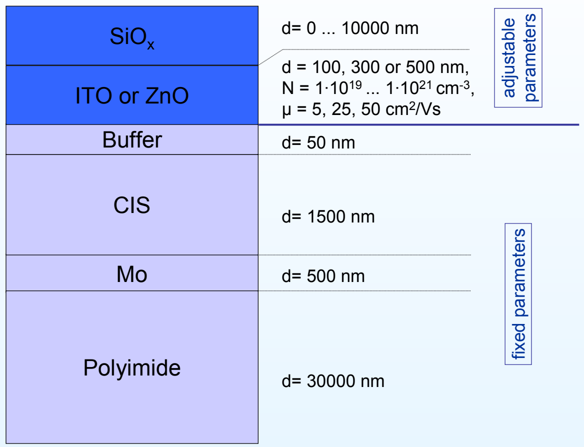
Model dielectric functions

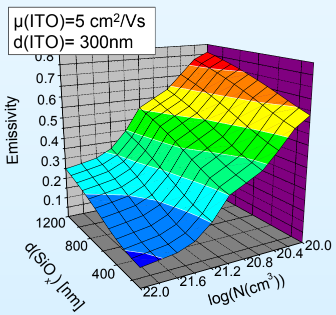
Determined by infrared spectroscopic ellipsometry:
SiO_x, ITO, ZnO, Buffer, CIS, Mo

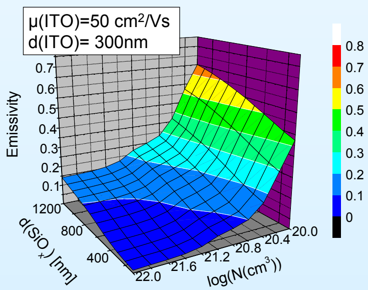
Taken from reference data:

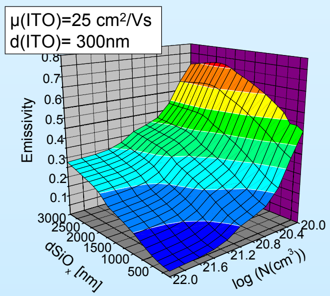
$a\text{-}Al_2O_3$ Chu et al., J. Appl Phys. 64, 3727 (1988)
MgF_2 Hunt et al., Phys. Rev. B 134, A688 (1964)

Basic structure I









Results

In order to increase maximum of emissivity, one has to:

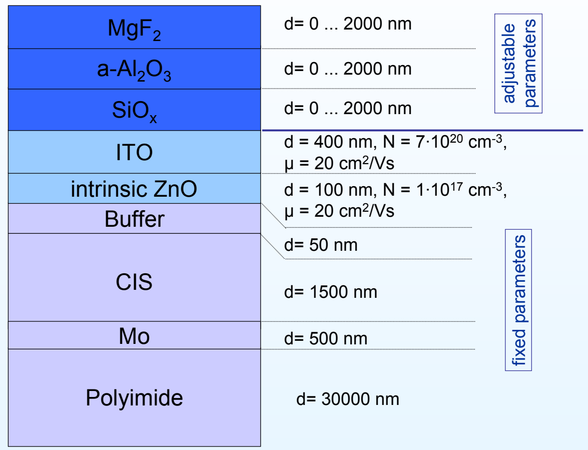
- decrease concentration and mobility of free charge carriers in ITO/ZnO-layer
- decrease thickness of ITO/ZnO-layer
- increase layer thickness of SiO_x-layer

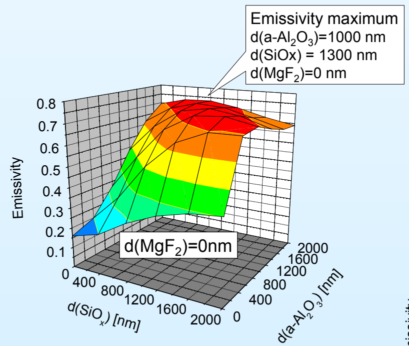
Problems

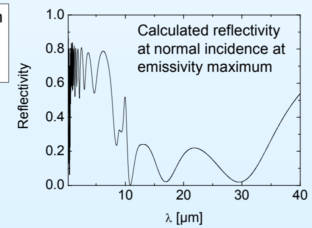
- Performance of solar cell structure
- Parameters of SiO_x, ITO, ZnO-layers technologically not feasible

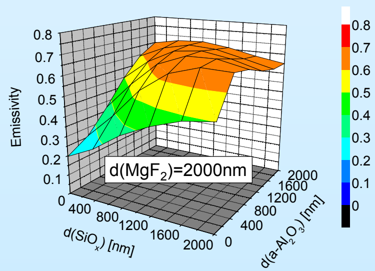
Solution ⇒ additional optimized layers, see Structure II

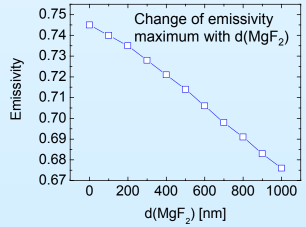
Optimized structure II











Results

- Amorphous Al_2O_3-layer increases emissivity up to 75%.
- MgF_2-layer decreases emissivity maximum.
- Parameters of SiO_x, ITO, ZnO-layers technologically feasible

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