Temperatuur meten in LED applicaties

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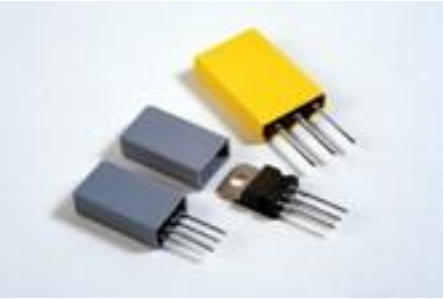
Ad Musters - Universal Science BV

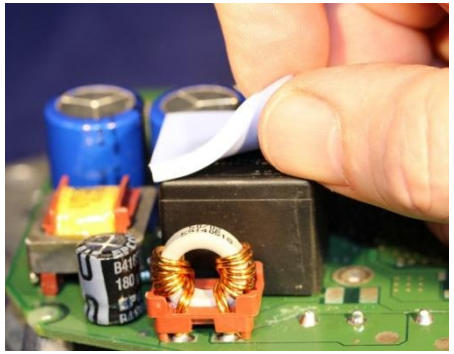
Indeling

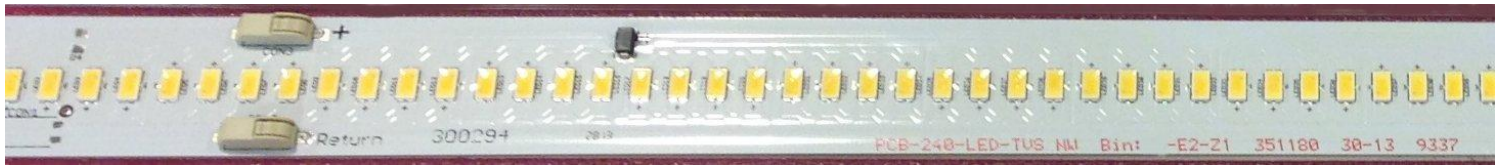
- Universal Science en OTS profiel.
- Waarom temperatuur meten en hoe meten?
- Meetmethodes en voorspellen/berekenen
- Uitleg hoe werkt een thermokoppel?
- Infrarood camera gebruik
- Led junction metingen
- Waar meet je en hoe?
- Interpretatie van de meetgegevens

Universal Science



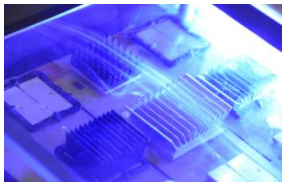
- Leverancier van printplaat materialen, thermal interface materialen zoals thermisch geleidende tape, silicone rubber.
- Producent en kennis centrum voor standaard en klantspecifieke LED modules.
- Zowel enkele stuks als hoog volume led module productie.

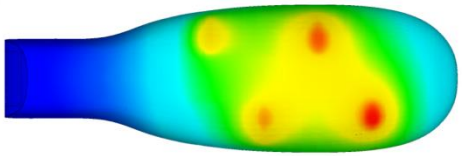


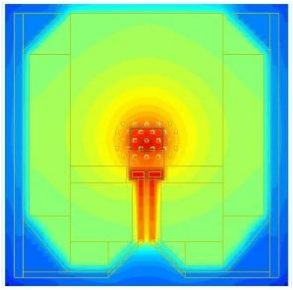


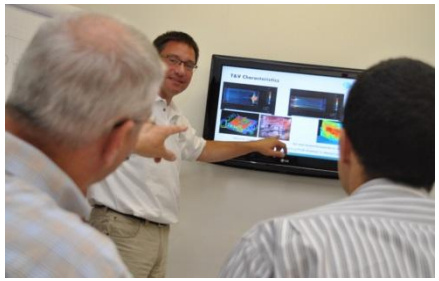
Optimal Thermal Solutions

- Thermal consultancy
- Thermisch laboratorium
- Ontwikkeling & verkoop koeloplossinge
- Test- & Meetapparatuur
- Trainingen





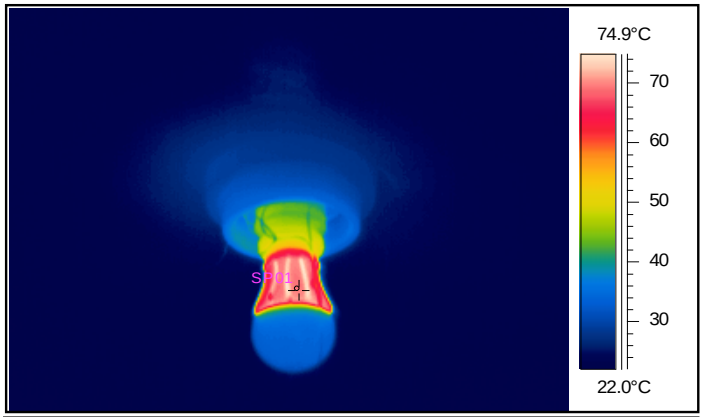


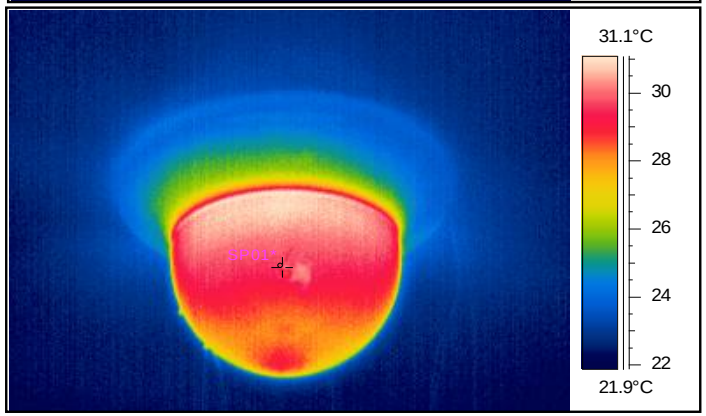


Waarom temperatuur meten?

1. *Functionele integriteit*
   Temperatuur te hoog => functionele fouten/falen
2. *Operationalele levensduur*
   De levensduur wordt beïnloed door de temperatuur. Een lage temperatuur verlengt de levensduur.
3. *Veiligheid*
   Voorkomen van overschrijden van materiaal specificatie (bijv. kunststoffen) en gevaar voor brand. Aanraak veiligheid.

Waar meet je de temperatuur 1





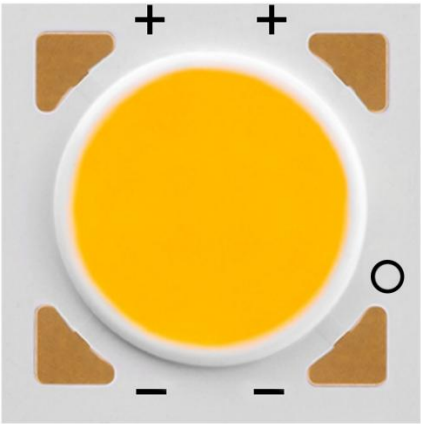
8W Led Lamp, 420 Lm
Thermokoppel op HS
Omgeving T is 22°C

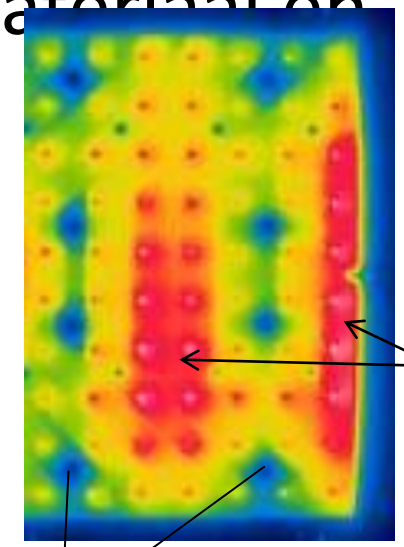
Zonder kap over de
LED lamp wordt HS
Oppervlak 62°C

Met kap over de lamp
Wordt het HS
Oppervlak :75°C

Waar meet je temperatuur 2

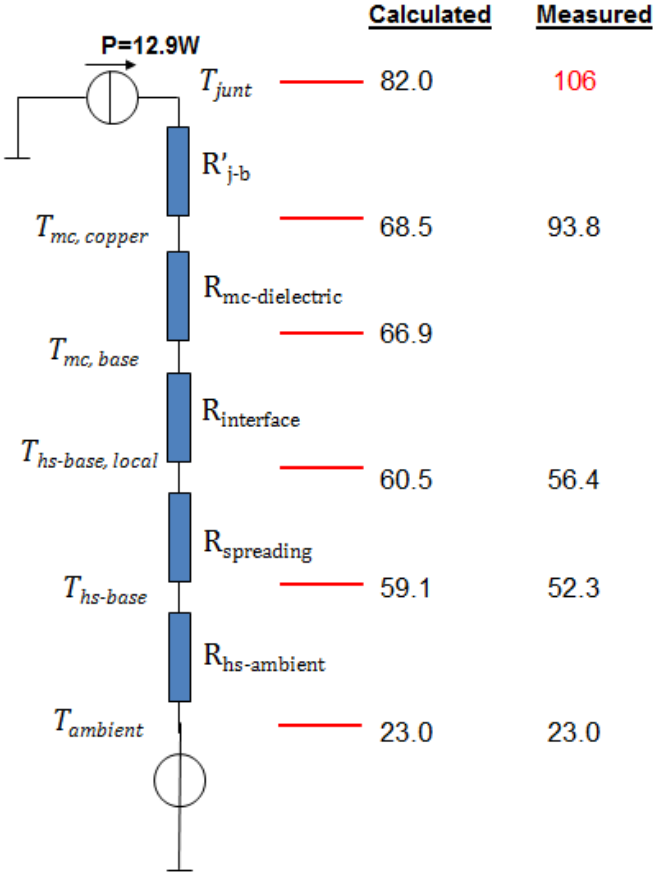
- Een temperatuursensor meet zijn eigen temperatuur
- COB modules, interface materiaal en heatsinks
-





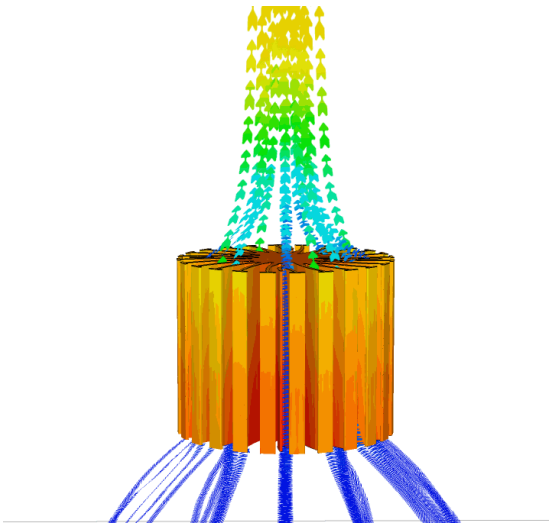
Analytisch

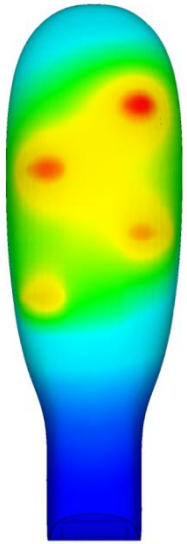
- Handmatige berekeningen
- Geeft snel inzicht of een ontwerp uberhaupt zal gaan werken en wat kritisch is "wat-als analyses"
- Conductie/convectie/straling
- Gebruik gegevens van datasheets

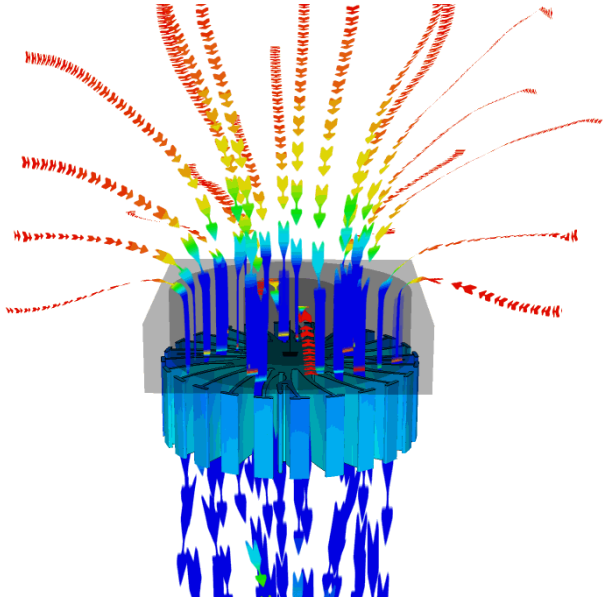


Simulatie

- In 3D modelleren van een probleem
- Doorrekenen van temperatuur/ druk/ een flow in x,y,z richting

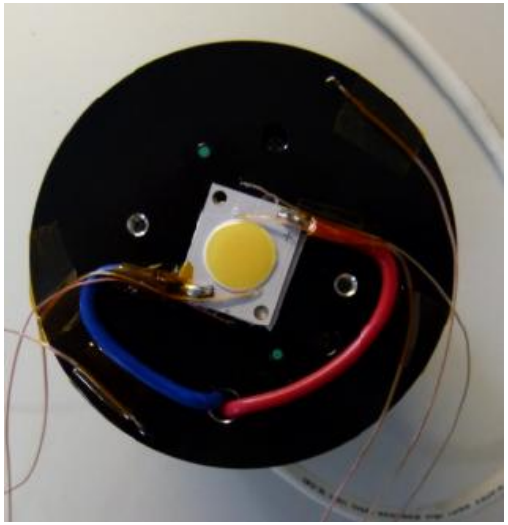


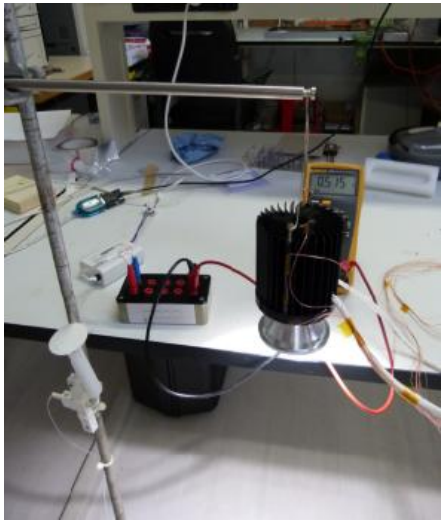


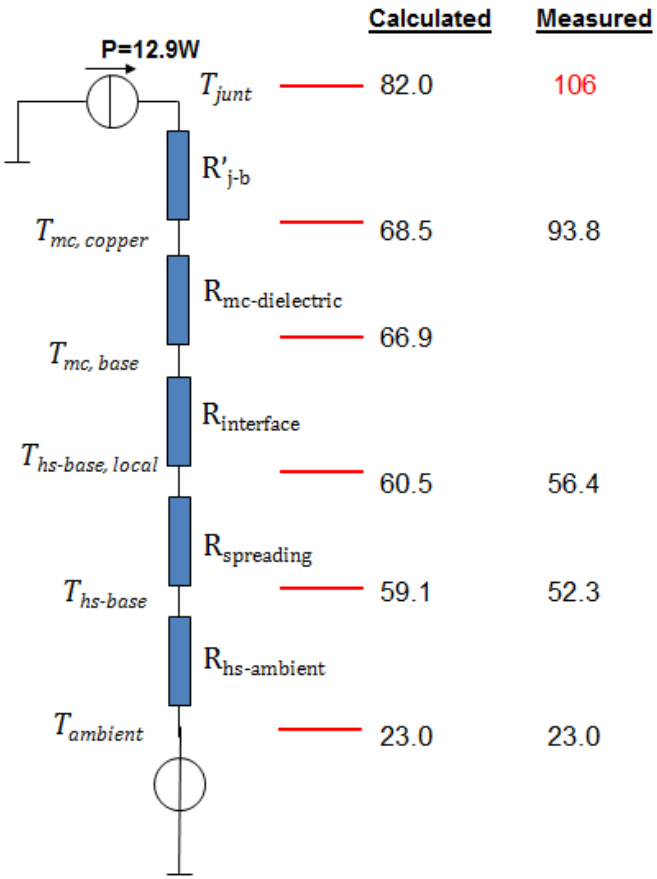


Experimenteel

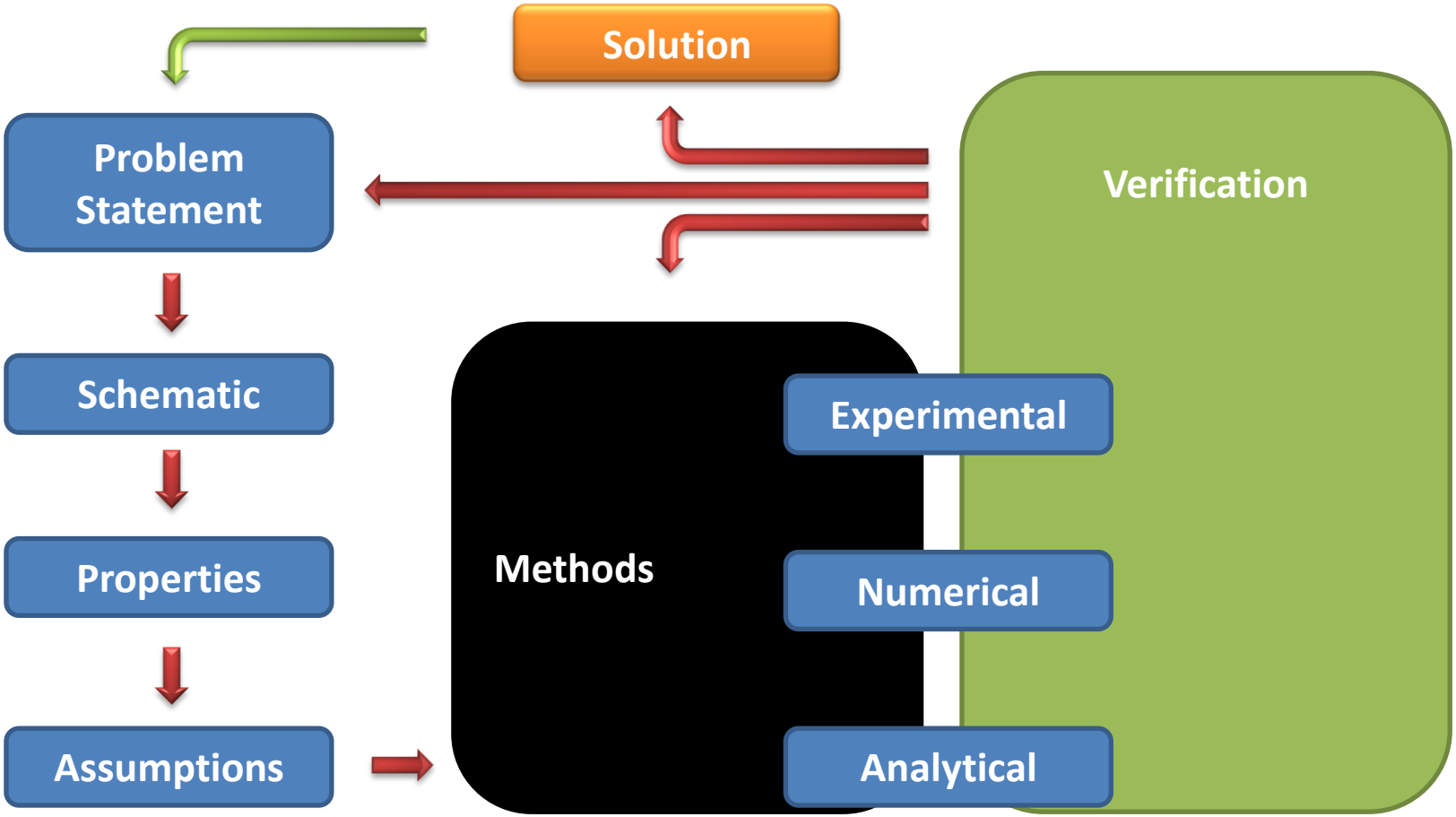
- Verificatie van de hardware







Het proces - schematisch

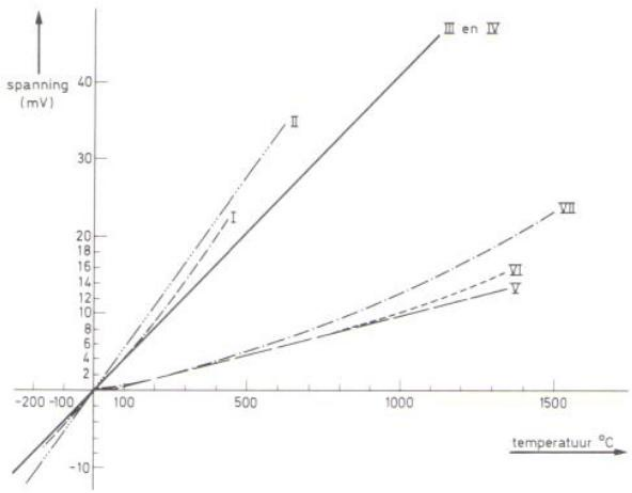


Welke meetmethode?

- Meten is weten! Maar weet je wat je meet?
- Door gebruik van drie methodes, analytisch/ numeriek en experimenteel krijg je inzicht in wat er gemeten moet worden, waar en hoe.
- Meting
  - Thermokoppel
  - Infrarood camera
  - Diode (junction) meting

Thermokoppel

- Iedere sensor meet zijn eigen temperatuur
- Thermokoppel is een lijn sensor geen punt



I = Cu + constantaan
II = Fe + constantaan
III = Ni/Cr + Ni
IV = chromel + alumel
V = Pt/Rh 10% + Pt
VI = Pt/Rh 13% + Pt
VII = Pt + Ir

$$EMF = \int_0^L \varepsilon_1 \frac{dT}{dx} dx + \int_L^0 \varepsilon_2 \frac{dT}{dx} dx$$

ε = total thermoelectric power of material mv/C

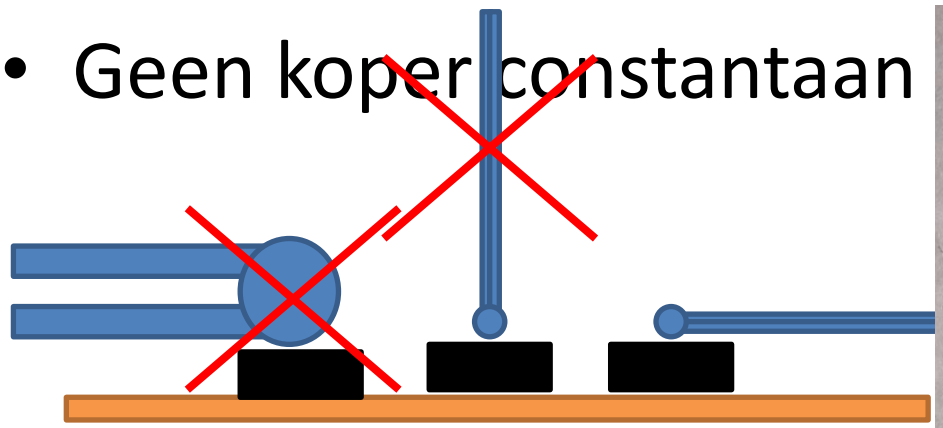
T = Temperature

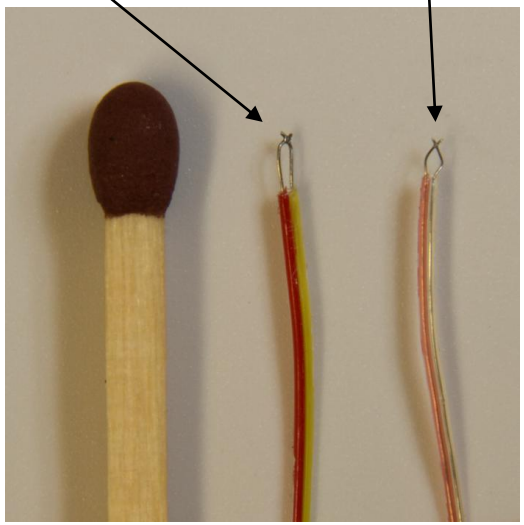
x = distance along the wire, m

L = length of the wire, m

Thermokoppel

- Contact oppervlak > 10x diameter, vastlijmen beste.
- platte las, niet in elkaar draaien.
- Diameter zo klein mogelijk
- Geen koper constantaan





Infrarood thermometrie 1

FLIR
i series

FLIR E
Series

FLIR T420

FLIR SC325

FLIR
t640

FLIR X8000

Infrarood thermometrie 2

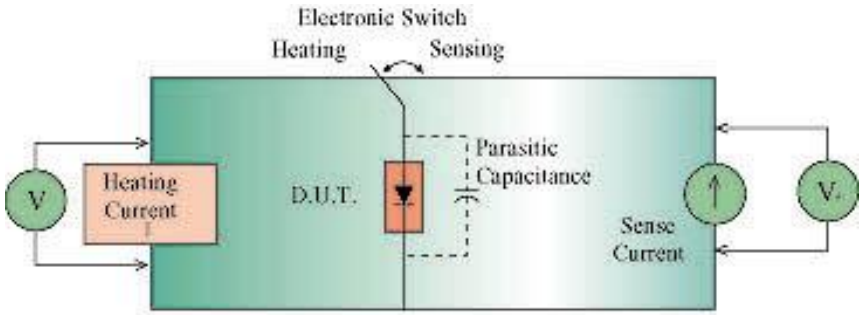
- Wat zijn de verschillen – waar betaal je voor?

Parameter	FLIR A40	FLIR i3	FLIR i5	FLIR i7	FLIR E30bx	FLIR E50bx	FLIR T420	FLIR SC325	FLIR T640	X8000 **
θ_H [°]	28	12.5	21	29	25	25	25	28	15	22
θ_V [°]	18	12.5	21	29	19	19	19	19	11	17
Hres. [pixel]	320	60	100	140	160	240	320	320	640	1280
Vres. [pixel]	240	60	100	140	120	180	240	240	480	1024
Focal Distance [mm]	300	600	600	600	400	400	400	400	500	400
IFOVm,MAX [mm]	1.4	6.6	6.7	6.7	3.3	2.2	1.7	1.9	0.6	0.4
Price indication (excl VAT) ***	€ 15 000	€ 1 000	€ 1 500	€ 2 100	€ 2 864	€ 5 254	€ 8 532	€ 14 000	€ 24 000	?

** X8000: Avaliable optics - 38° x 31°, 22° x 17°, 11° x 9°, 5.5° x 4.4° and close up x3 (6.4 x 5.1 mm, IFOV ~= 5 µm)

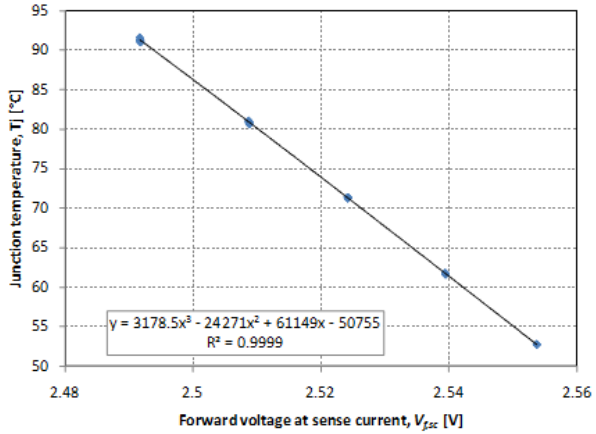
*** Price indication purely as reference. Macro lens for SC325: ~€2000.-

Junction temperatuur meten 1

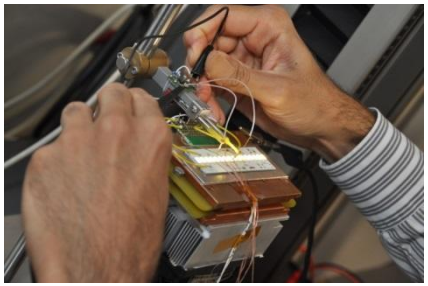


$T_j = m * V_f + T_0$

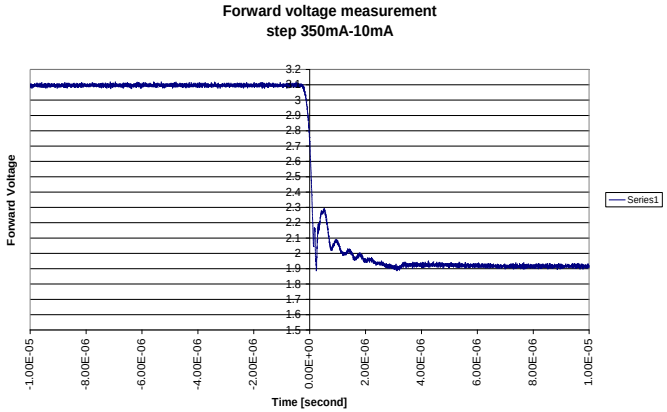
$R_{th} = (T_j - T_0) / (V * I)$



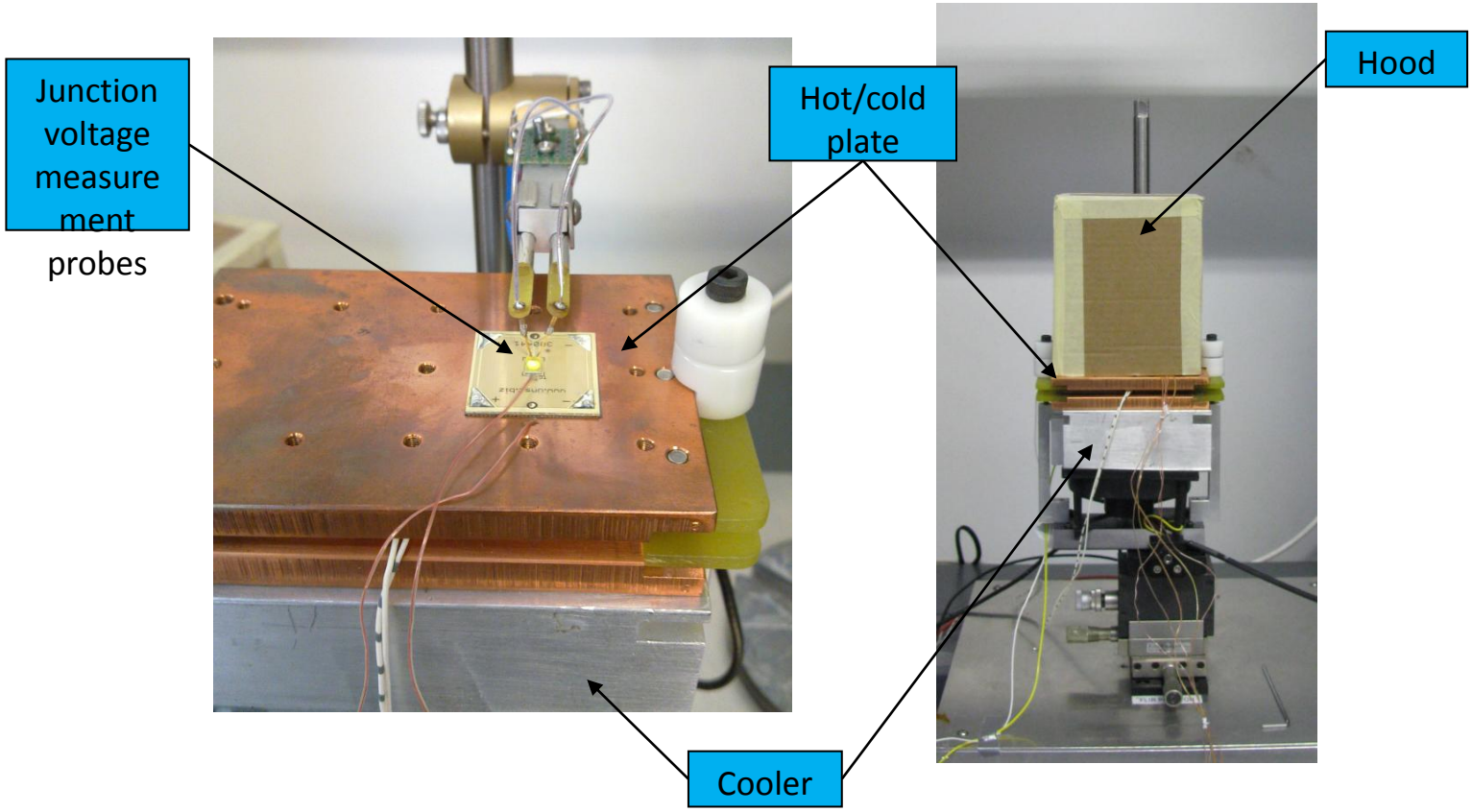
Kalibratie curve



Gemeten sprong in forward voltage, weergegeven in µseconden



Junction temperatuur meten 2

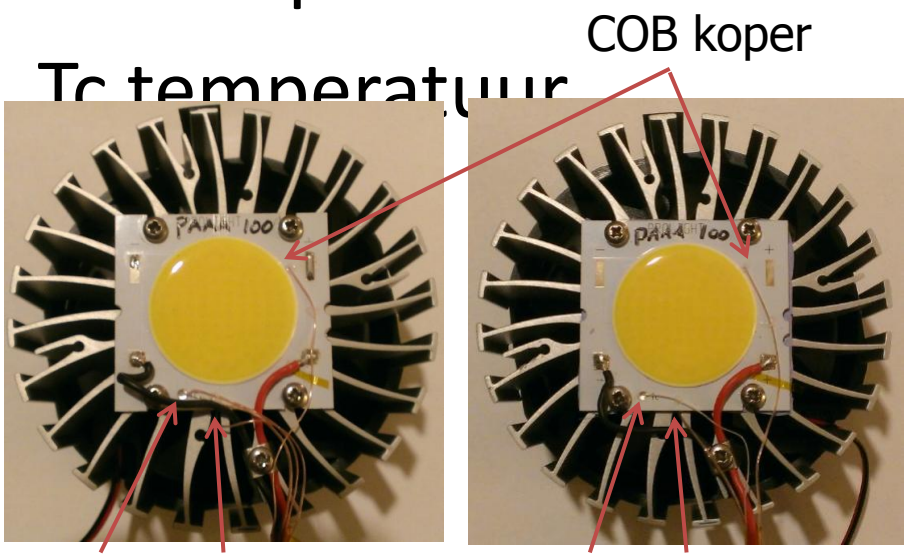


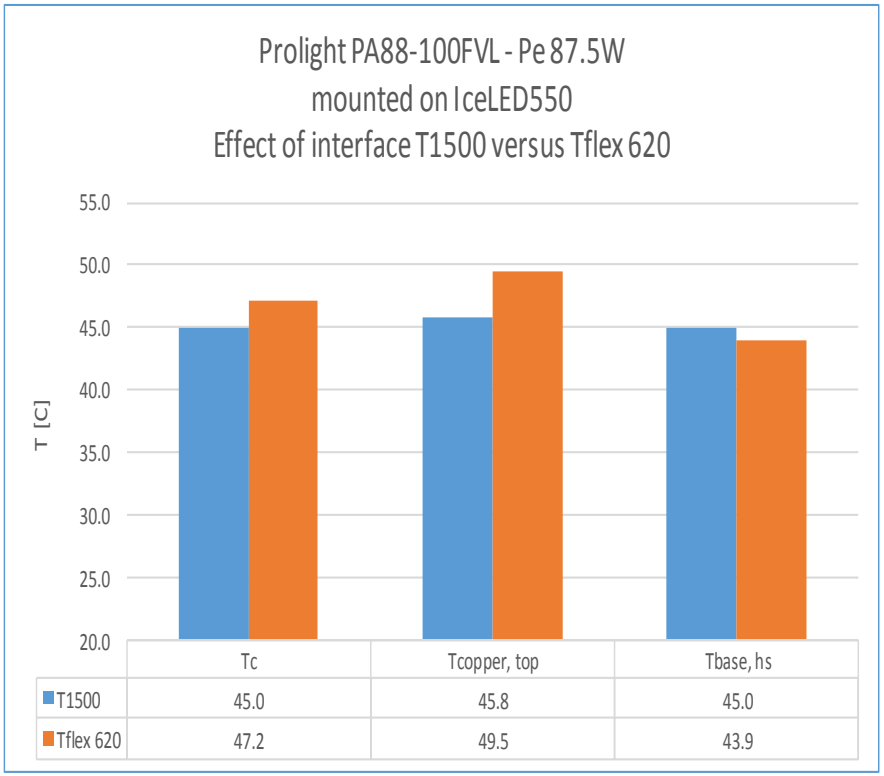
Test setup: Effect van Interface

COB temperatuur

HS temperatuur

Tc temperatuur





Interpretatie van Meetresultaten

- Vergelijk berekening, simulatie, meting
- Verklaar de verschillen
- Rapporteer de resultaten
- Maak een conclusie met aanbevelingen

OTS

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UNIVERSAL SCIENCE
COOLING ELECTRONICS BY DESIGN

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