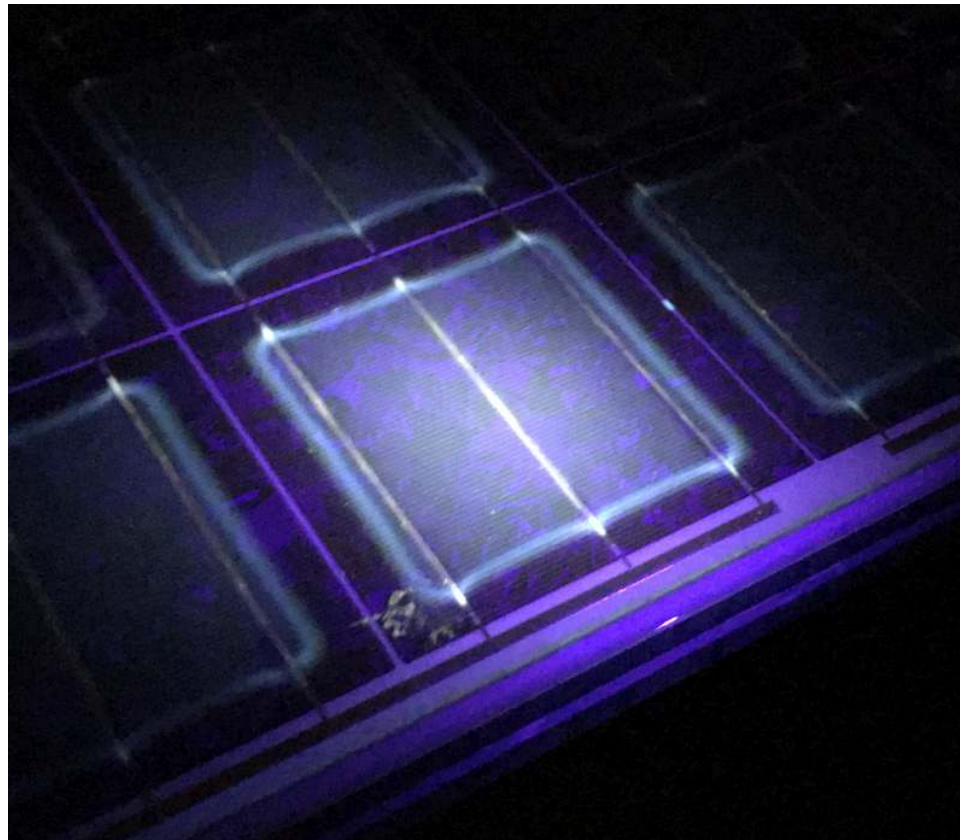


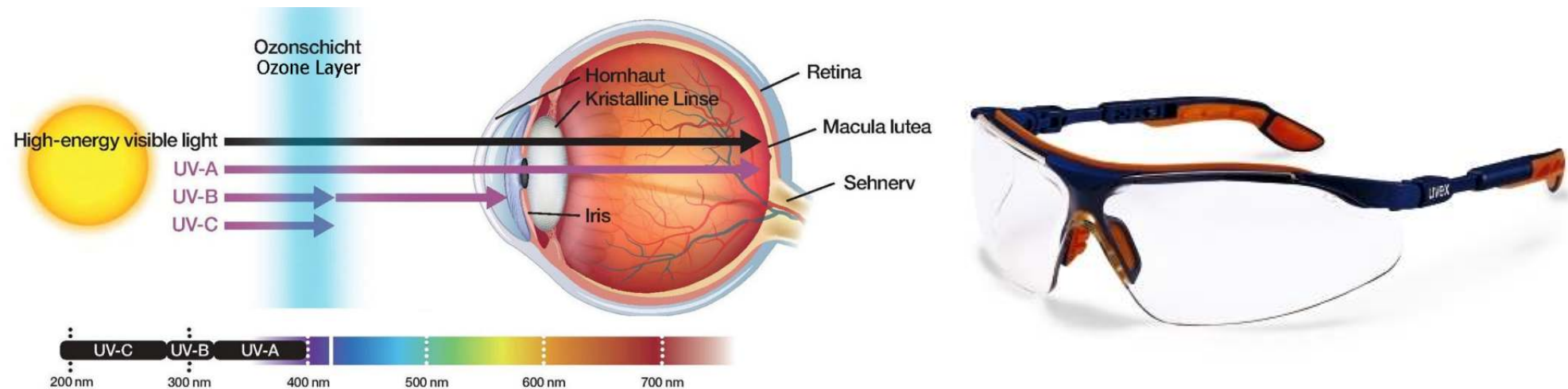
UV-Fluorescence Workshop ISFH 2018-10-12

UV-Fluorescence: Experiences from the Field

Eckhard Fleiss - Fleiss Engineering, Springe-Eldagsen
Matthias Diehl - photovoltaikbuero Ternus & Diehl, Rüsselsheim



Be aware of dangers to health! Wear UV-protection glasses!

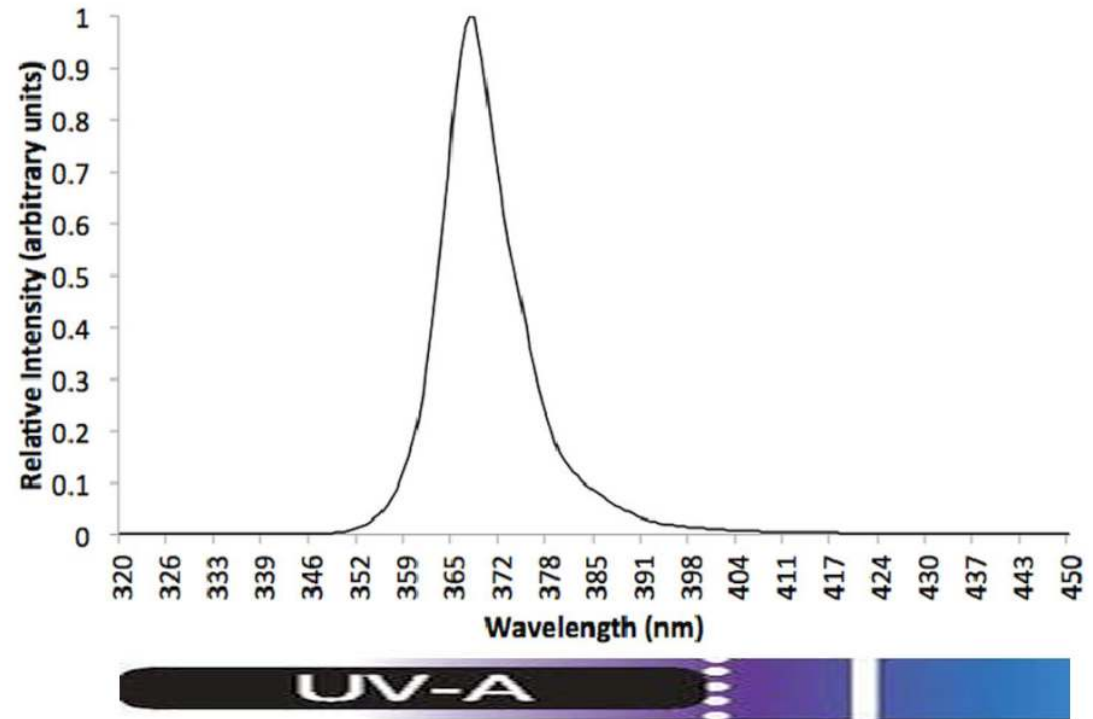


**DIRECTIVE 2006/25/EC OF THE EUROPEAN PARLIAMENT
AND OF THE COUNCIL**

of 5 April 2006

**on the minimum health and safety requirements regarding the
exposure of workers to risks arising from physical agents
(artificial optical radiation) (19th individual Directive within the
meaning of Article 16(1) of Directive 89/391/EEC)**

Portable UV-A inspection lamp



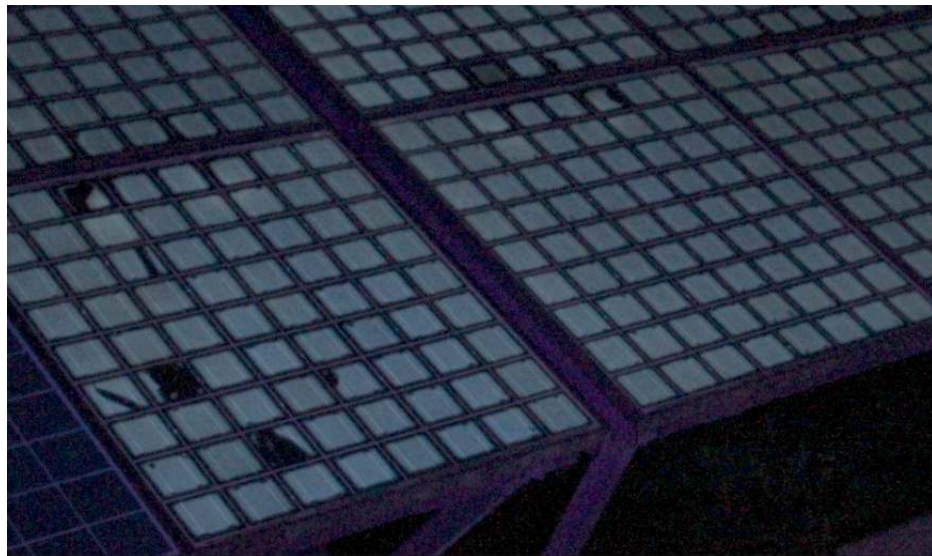
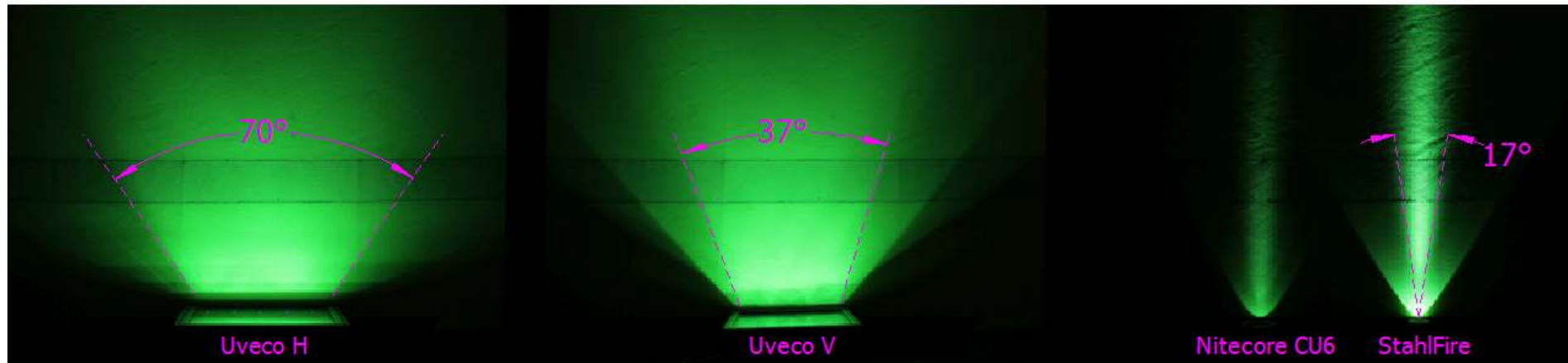
15x Nichia 365nm, 2W each (power consumption), 0.78W each (radiant flux)

Portable UV inspection lamp vs. pocket-size UV flashlight

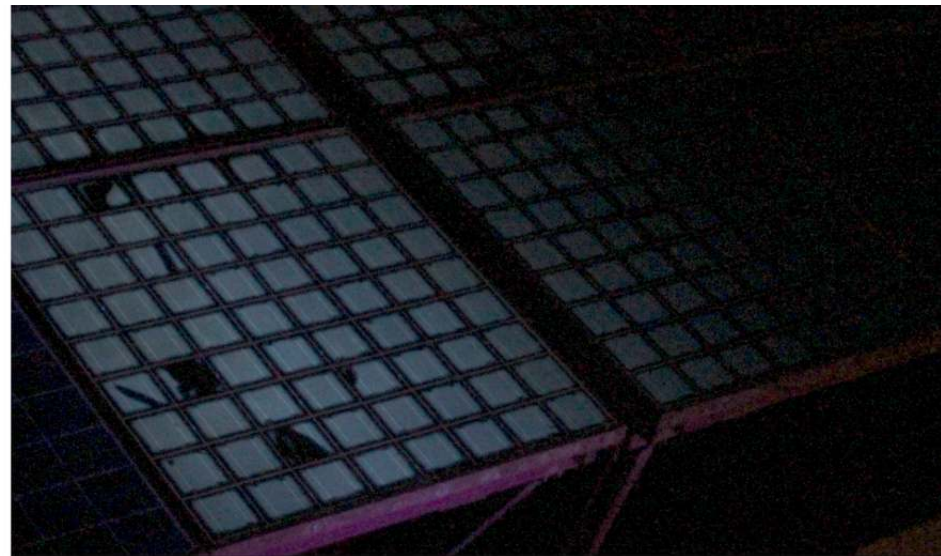


Same LED but driven at 850mA over-current giving 170% radiant flux, i.e. $\sim 1.4\text{W}$

Comparison of Intensity and Directivity



UV inspection lamp (flood)



UV flashlight (spot)

(both pictures taken with Canon EOS 600D, 1/5s, f2.0, ISO3200)

Working with the handheld inspection lamp



Freehand picture taken with Canon Power Shot G7 X, 1/6s, f1.8, ISO6400

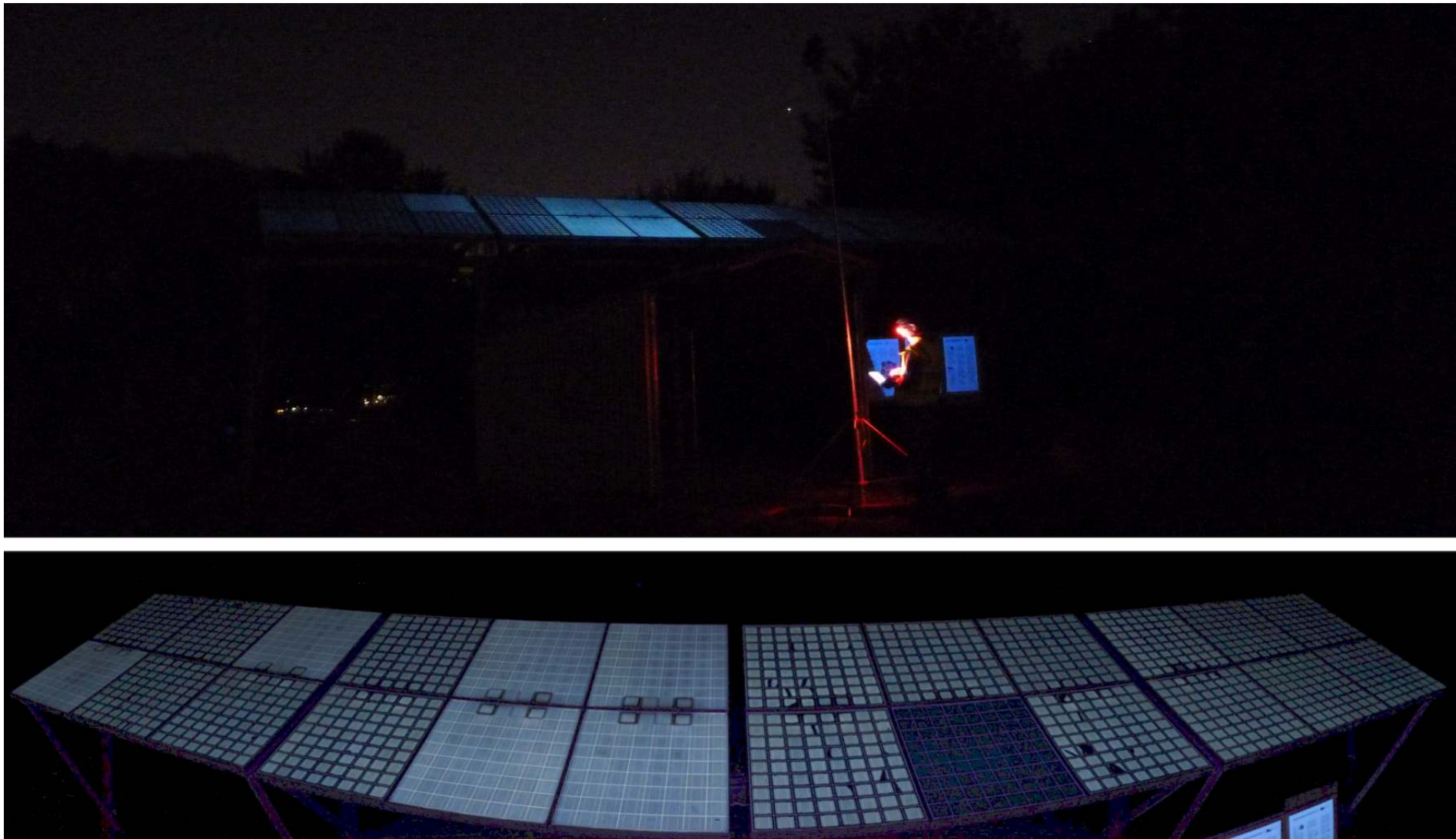


Working with the handheld inspection lamp...



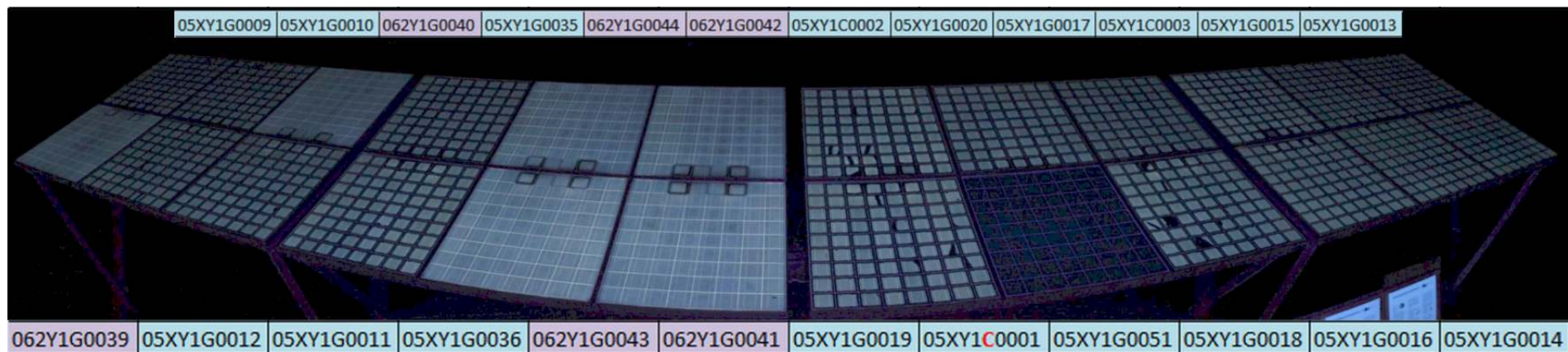
...from a high camera stand with motorized cam-head, remote shooting

Working with the handheld inspection lamp...



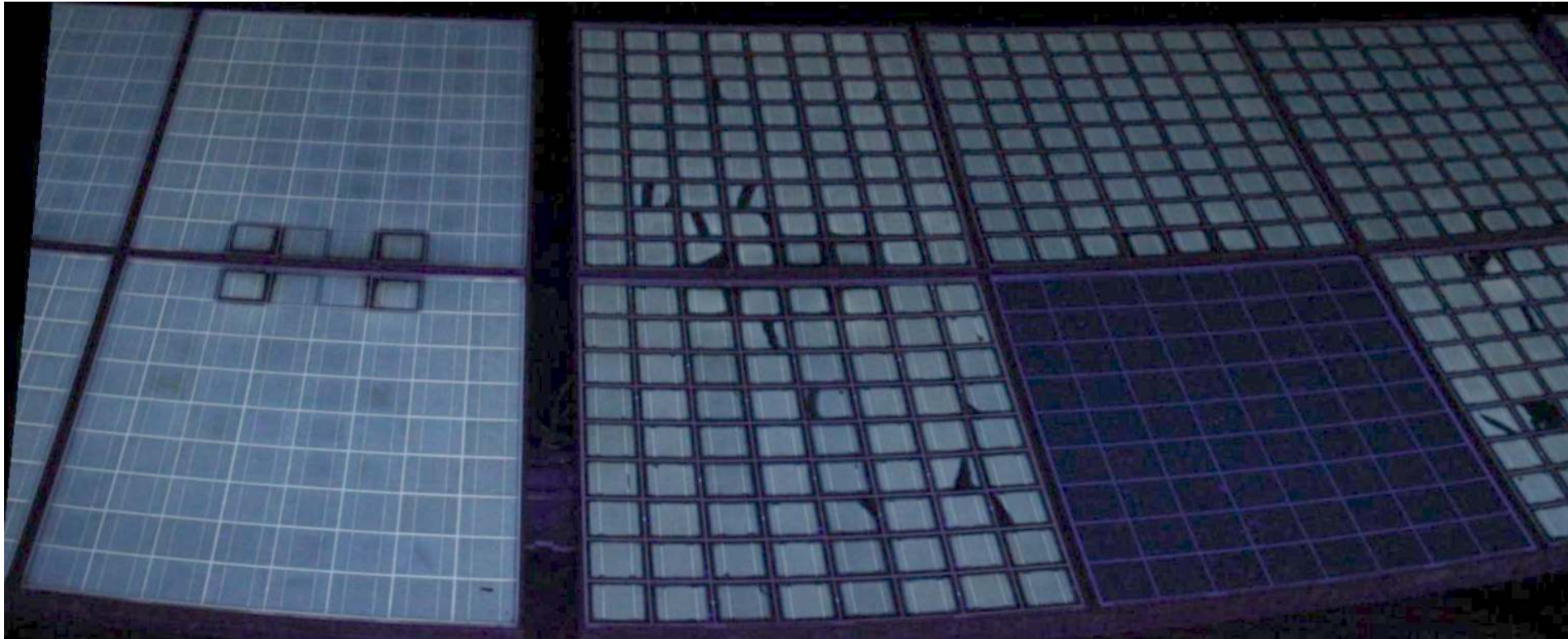
Multi-picture panoramic overview (Gamma 2.0 for improved clarity)

Overall appearance gives hints to manufacturing culture



we can sometimes distinguish SN ranges, i.e. Mfg date, factory / line, BOM?

Zooming in gives hints to



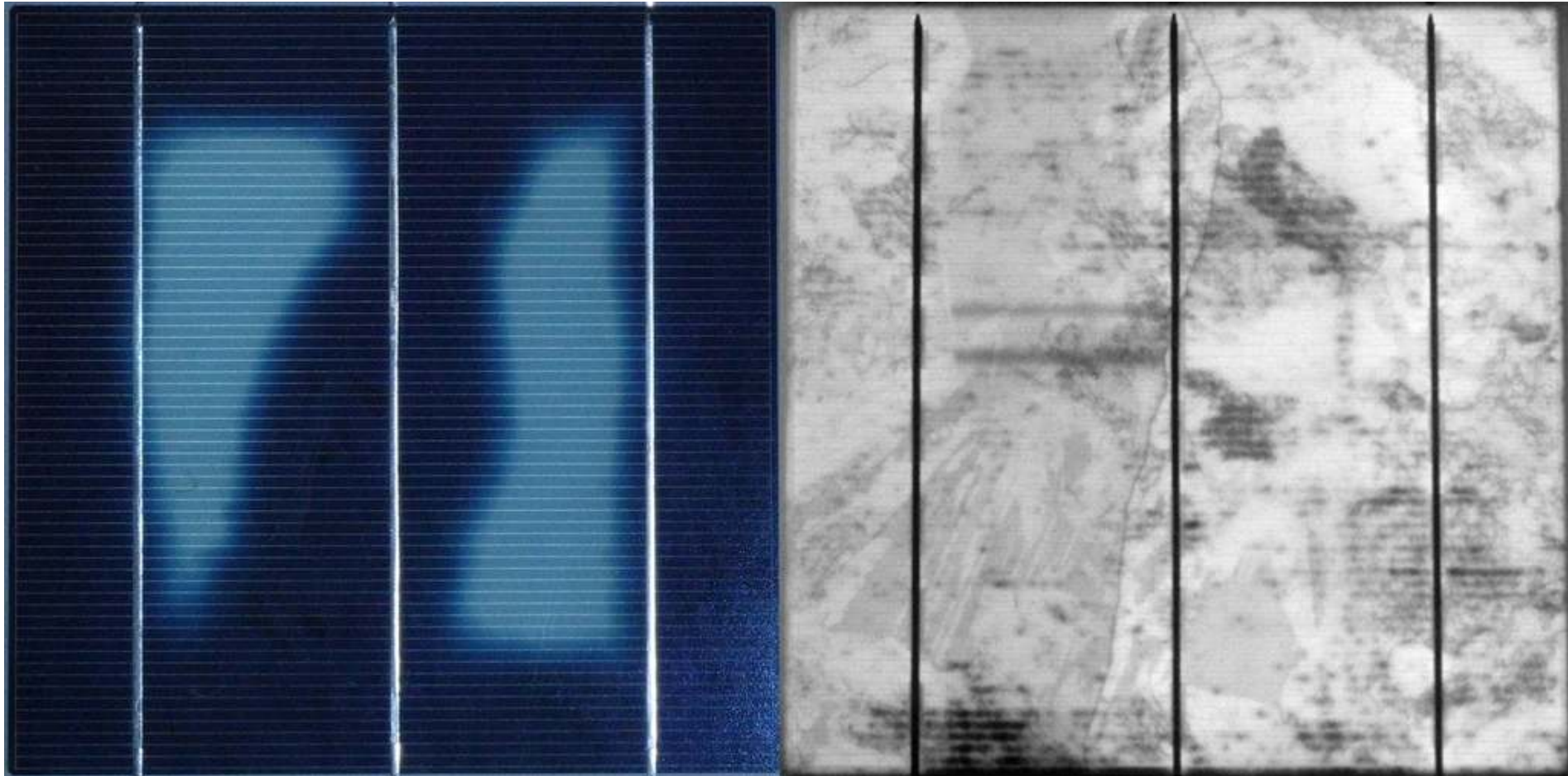
position of JB - why?
intrusion-path for O_2 or
chemistry of sealing?

old cell cracks,
if BS sufficiently
permeable

nothing at all,
if BS totally open or
non-fluorescent EVA

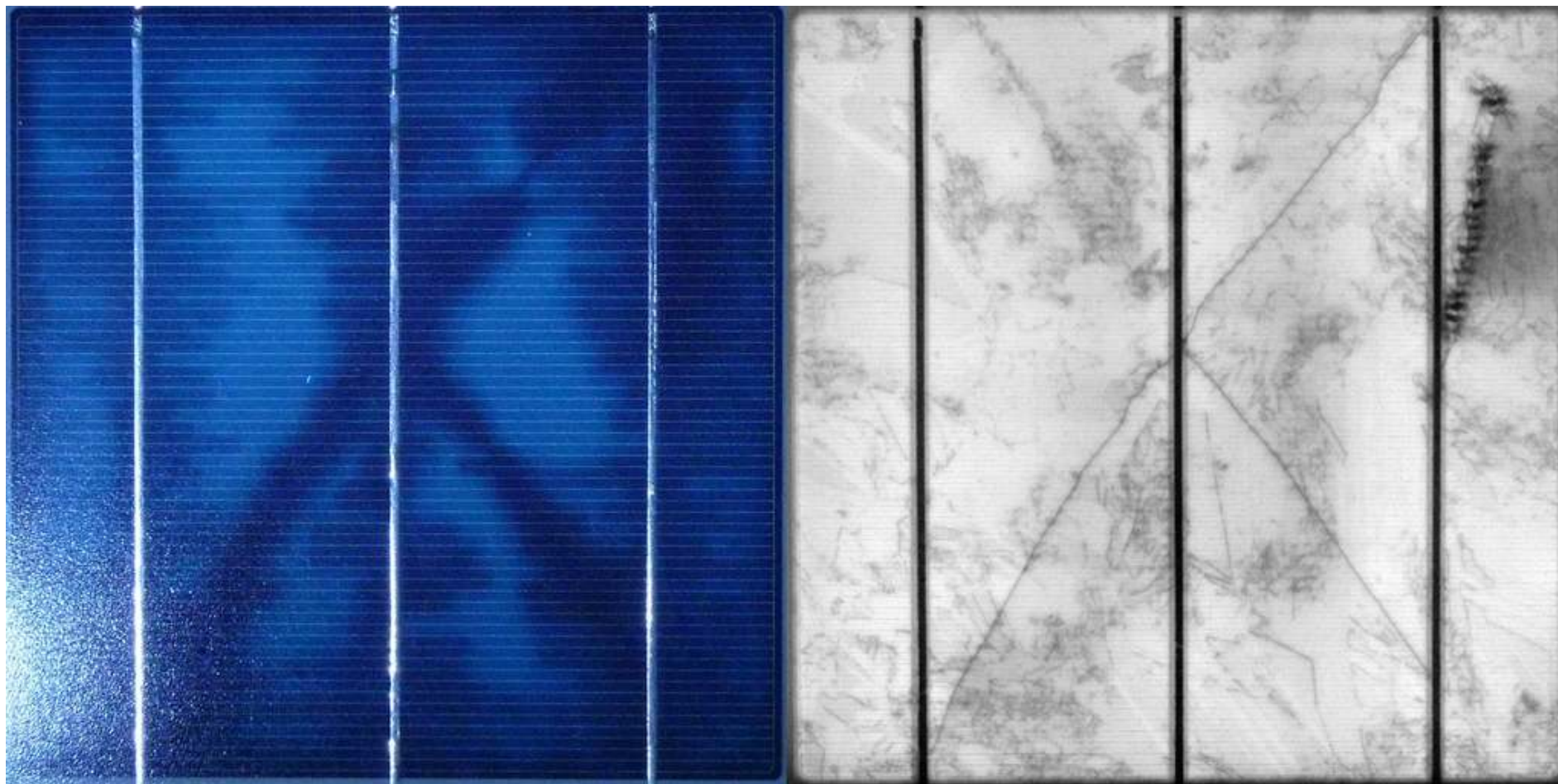


Detailed view on cell-level gives hints to



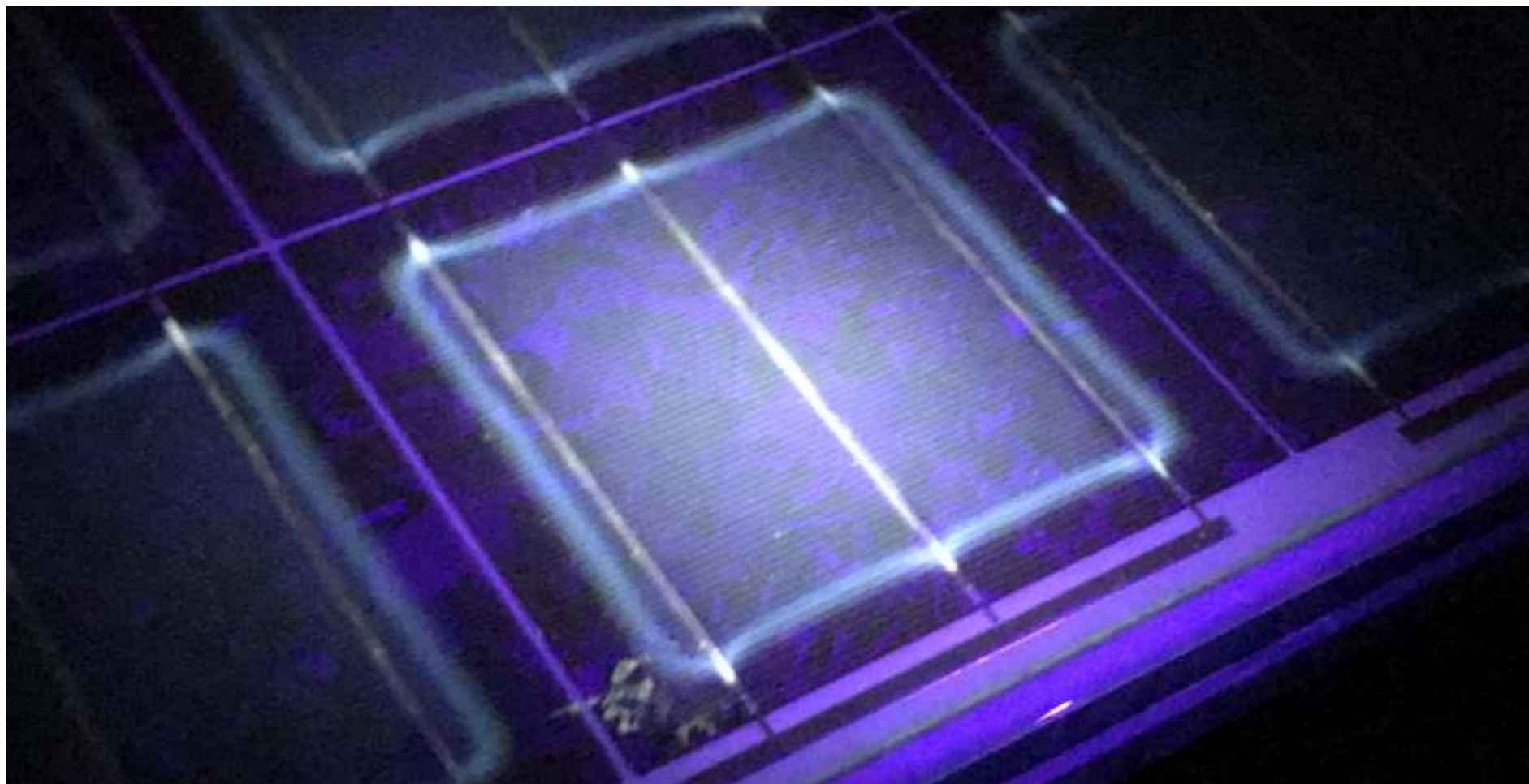
old cell cracks, distinguishable from newer ones in combination with with EL

Detailed view on cell-level gives hints to



old cell cracks, distinguishable from newer ones in combination with with EL
quality of lamination process (O_2 diffusion along grind fingers)?

Detailed view on cell-level gives hints to



...surprising things - enhanced fluorescence by agglomerating fluorophores?

Customer: Oh, is it defective?

Me: Ahem, don't think so...



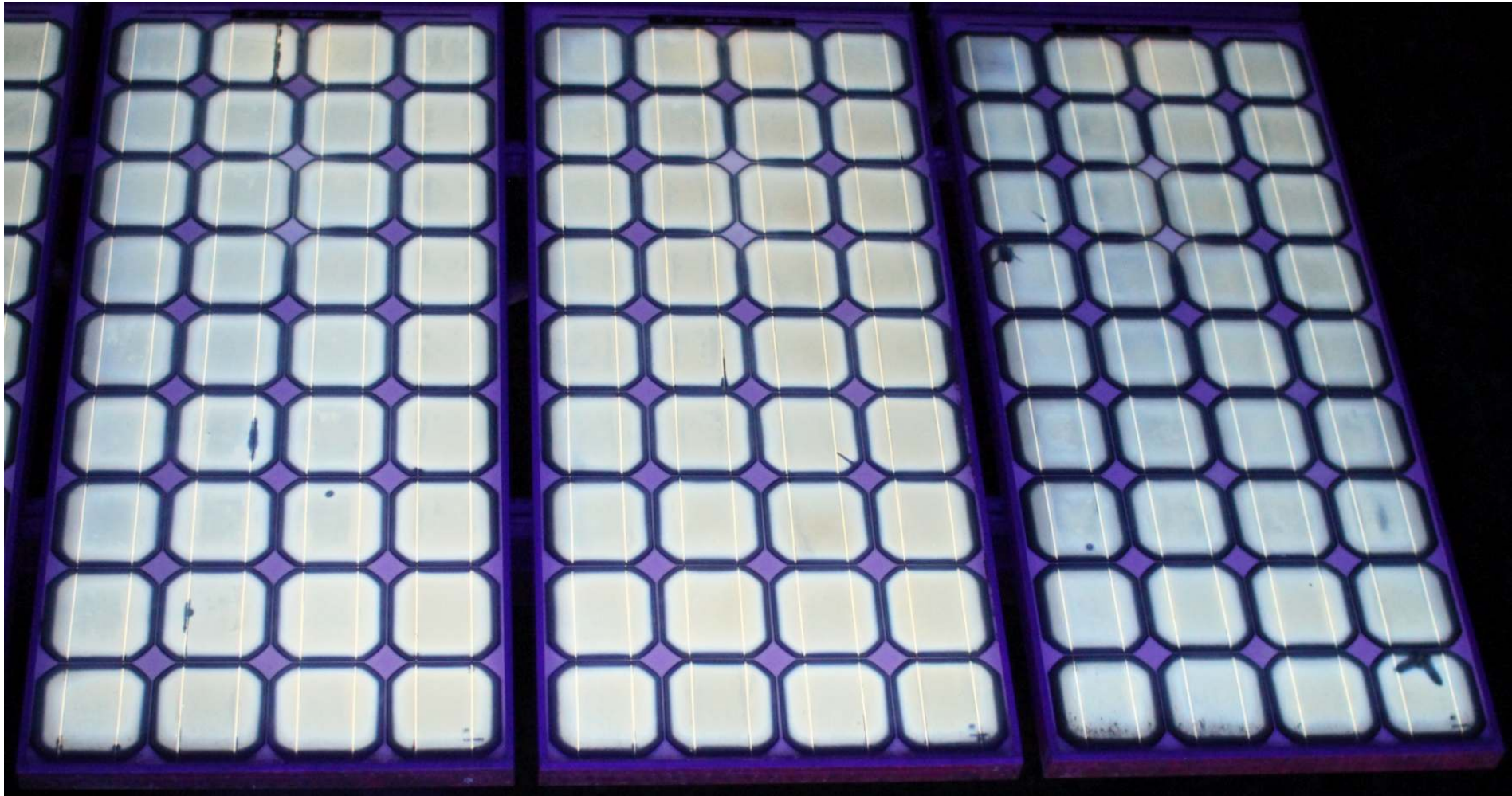
Some more impressions



cz-Si BP585
from 1998
near Hanover

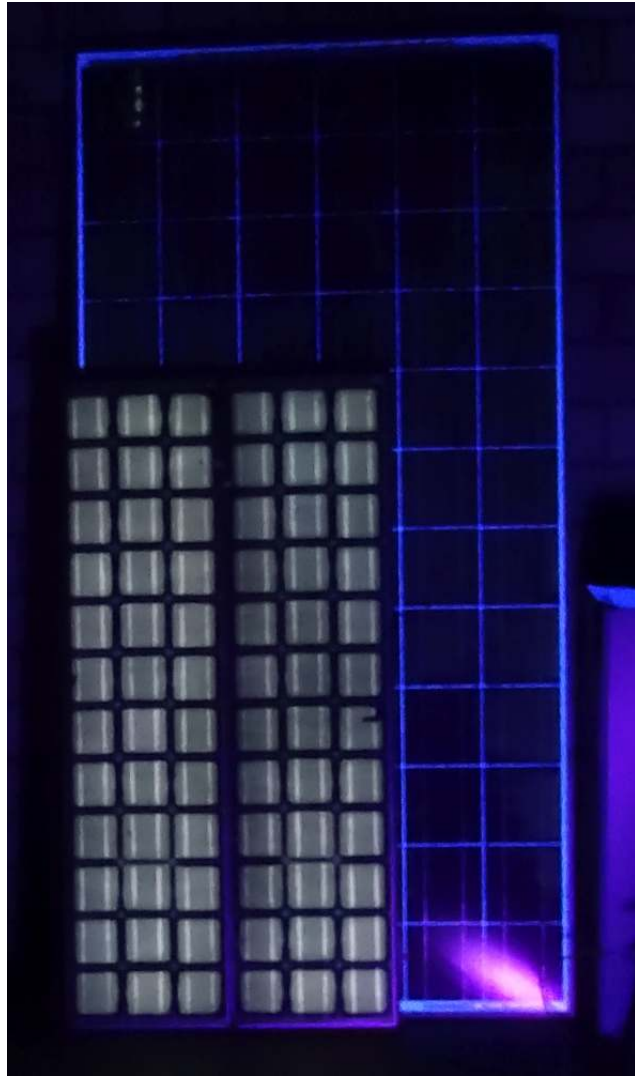
homogeneous
appearance,
almost no cracks

Zooming in shows



quenched fluorescence along tabbing -> chemical influence of flux?

Some more impressions from photovoltaikbuero.de

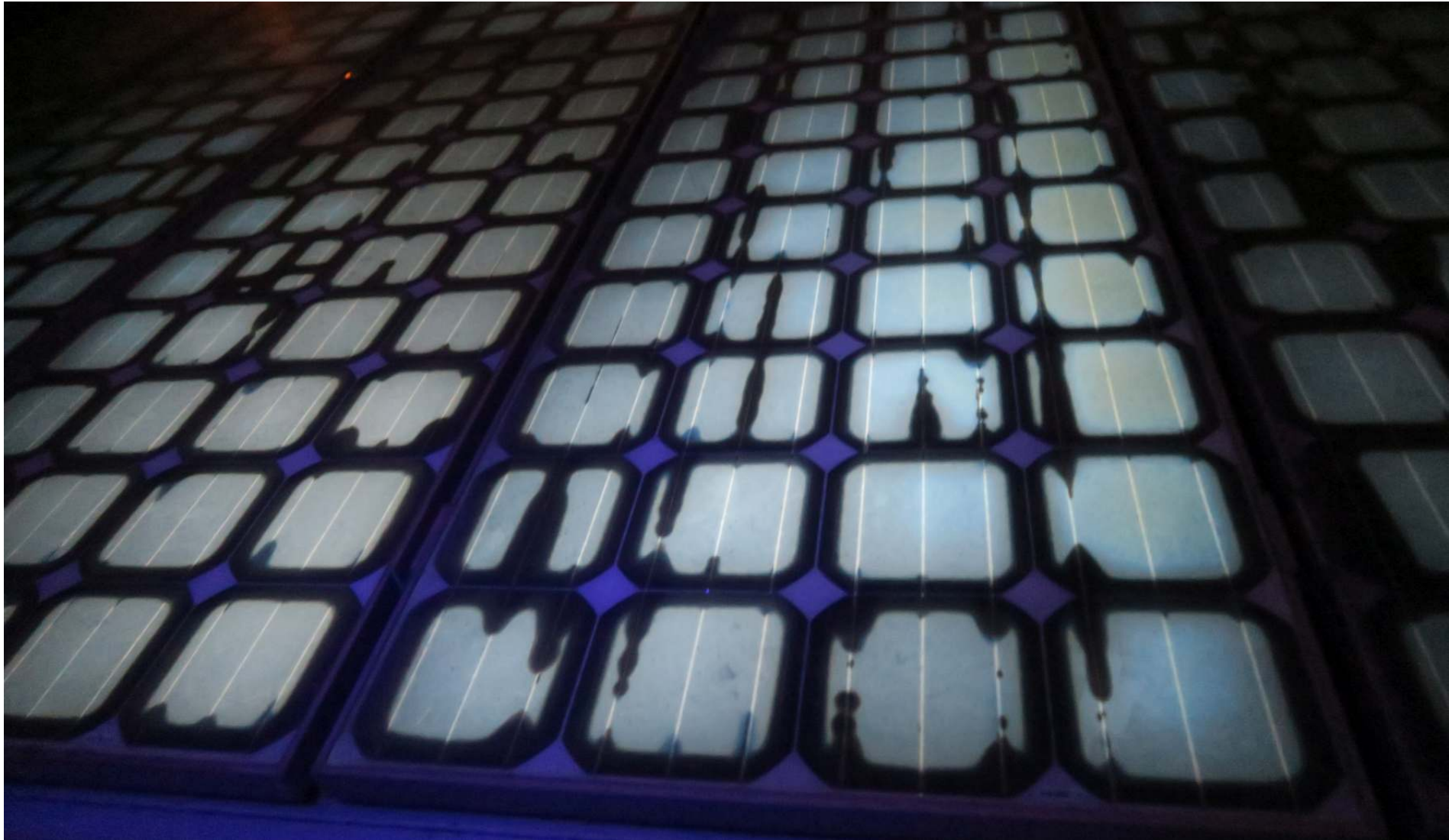


old Siemens M53 vs. young
poly-Si w/o fluorescence



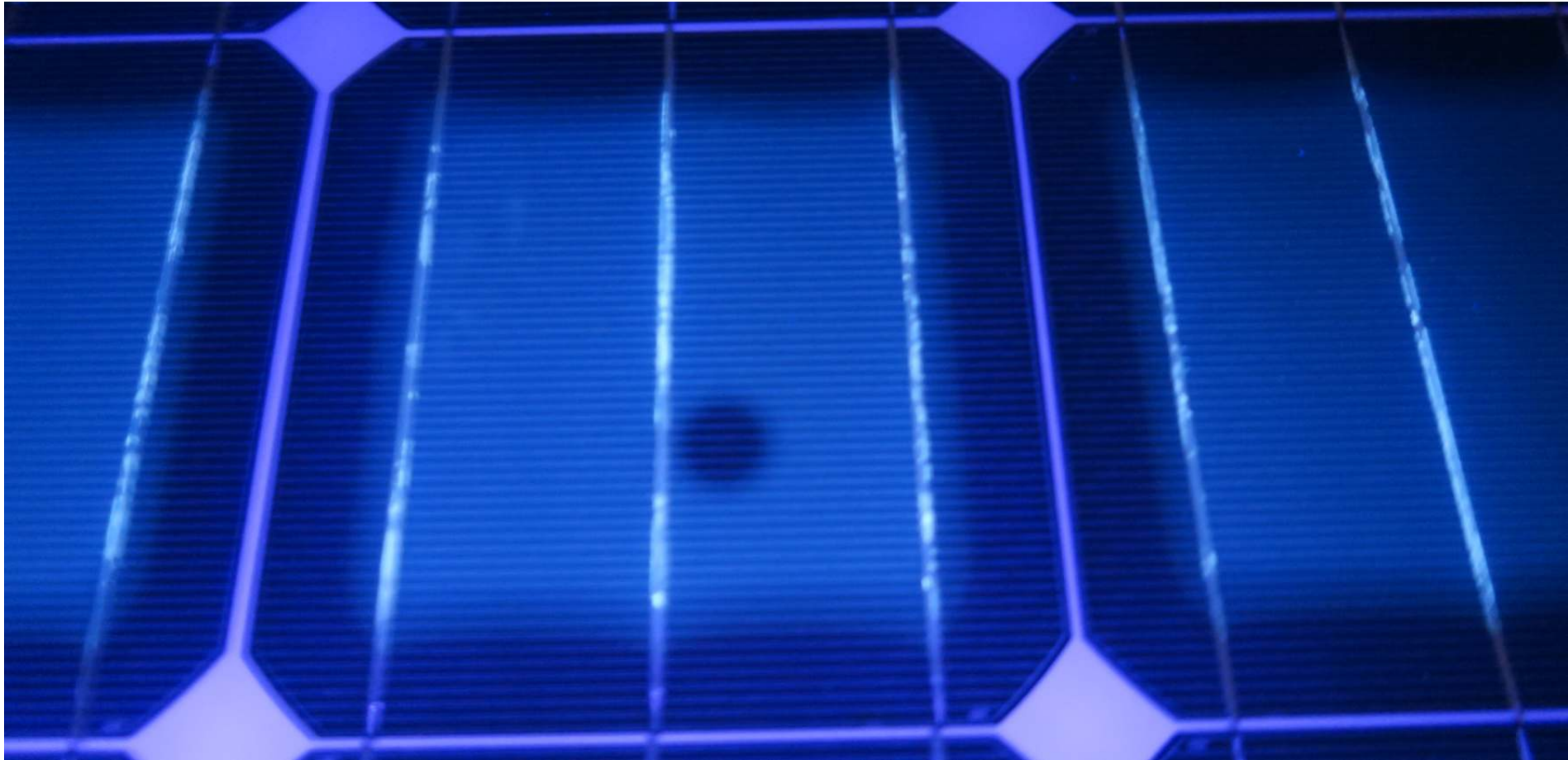
optical effects along tabbings

Some more impressions from photovoltaikbuero.de



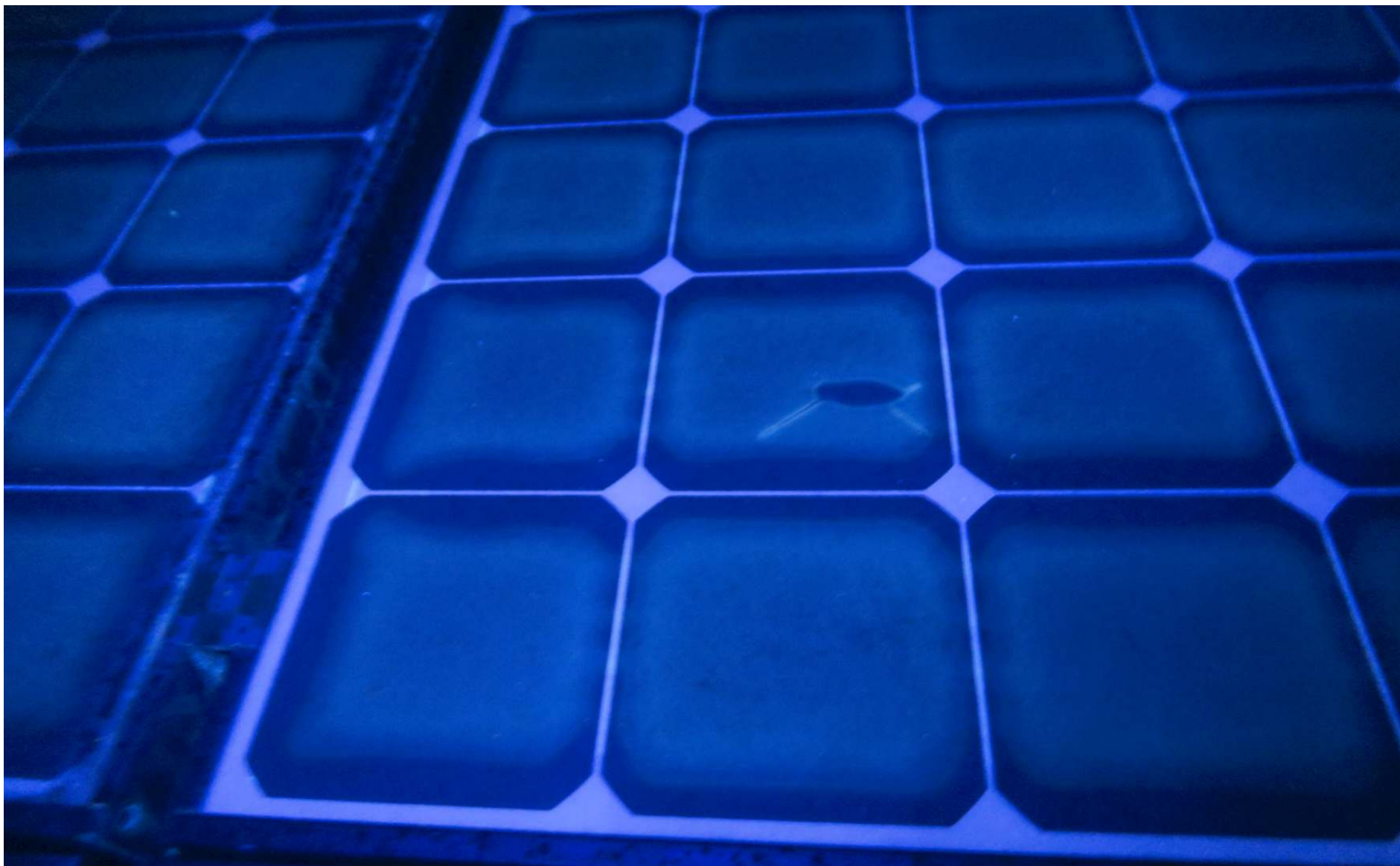
old Helios cz-Si modules with quenched fluorescence along tabbings

Some more impressions from photovoltaikbuero.de



Suntech-Power 250W_p cz-Si module with spot-like quenched fluorescence

Some more impressions from photovoltaikbuero.de



Sunpower BC module with spot-like quenched fluorescence and local crack?

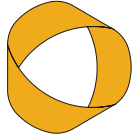
Thank you for your kind attention!

INGENIEURBÜRO FLEISS

ECKHARD FLEISS

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