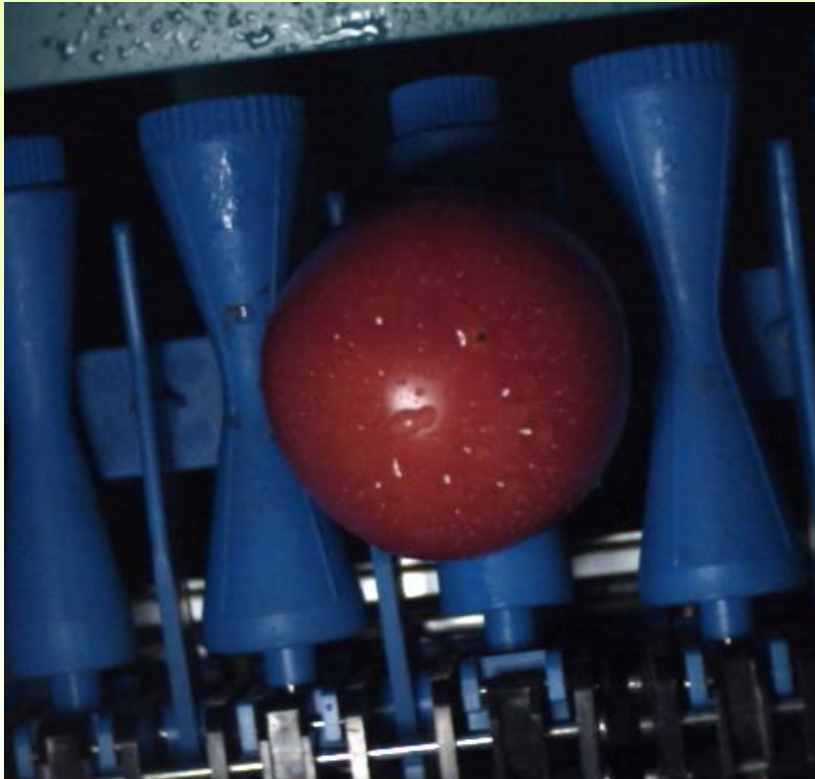


Effectiveness of PL Filtering Image with Halogen Lamp for Agricultural Products



Problems on image acquisition

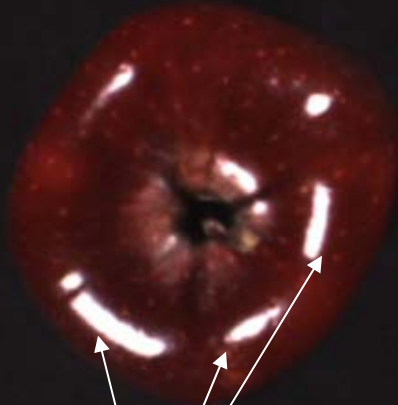


Halation

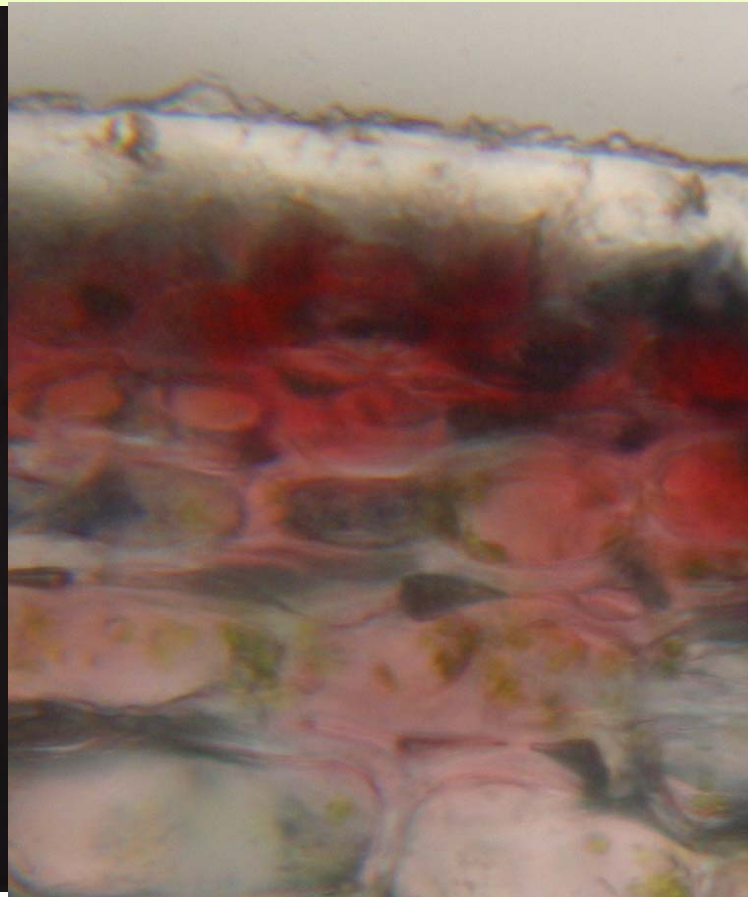


Surrounding walls reflection

Cuticular layer of apple fruit



Halation



Cuticular layer

Epidermis

Parenchyma

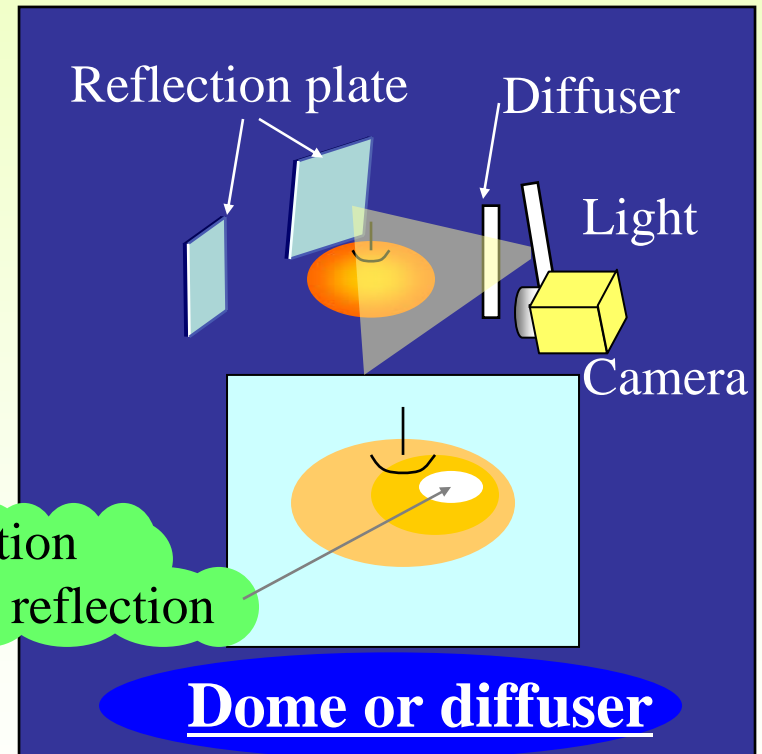
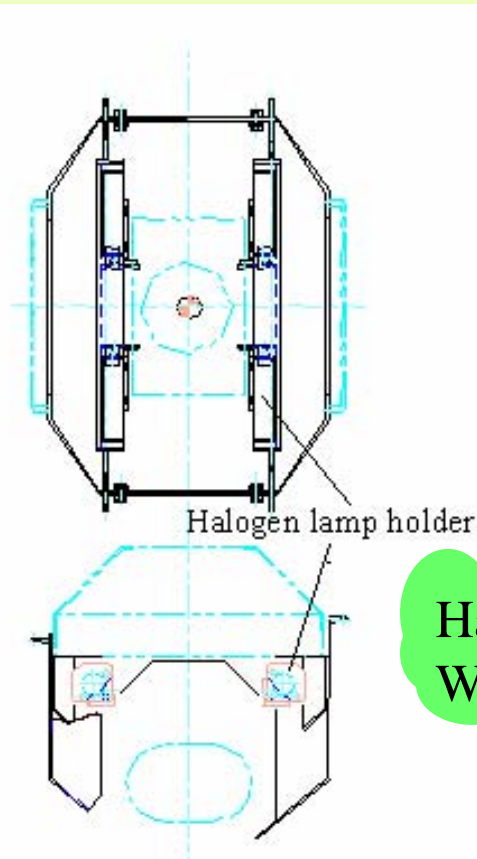


Objectives

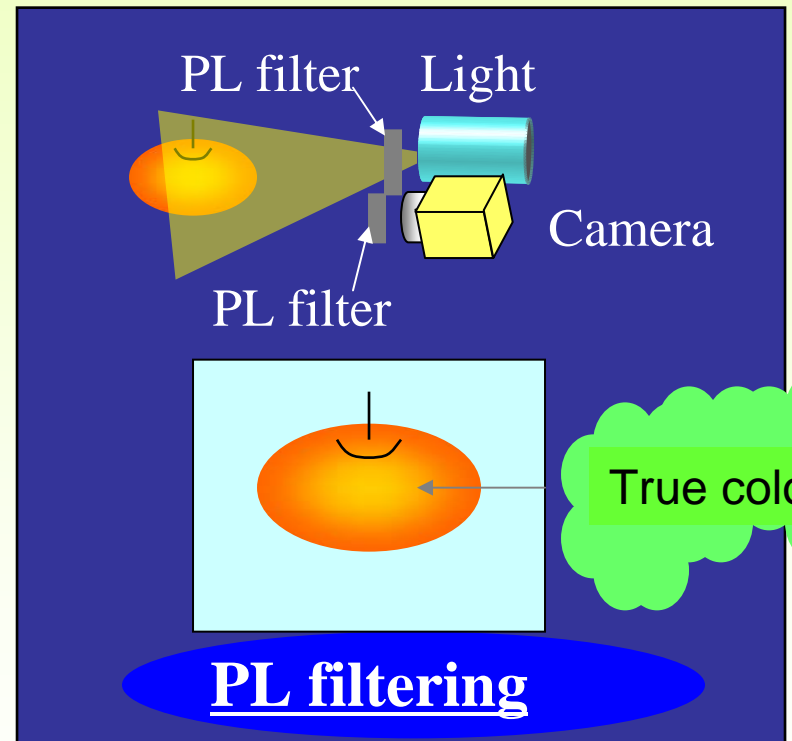
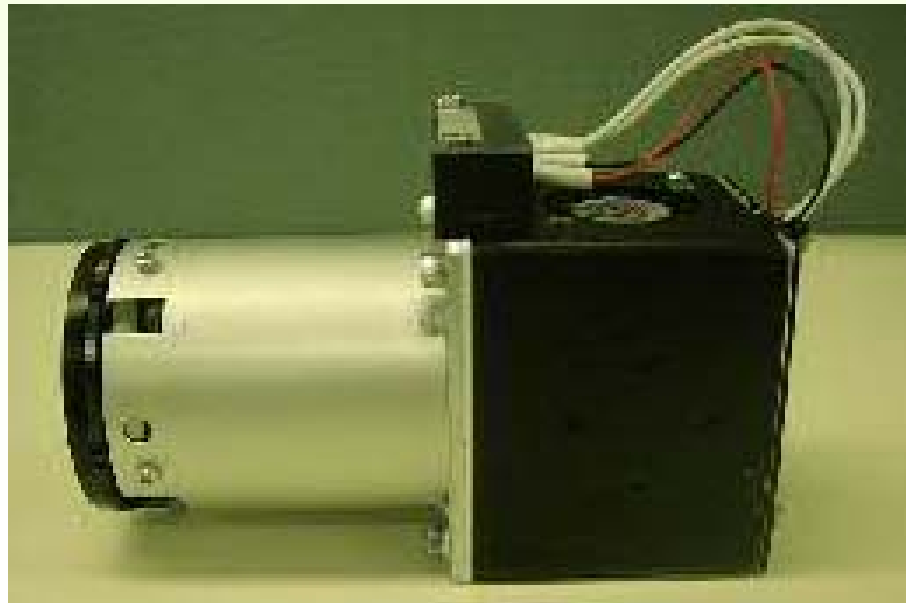
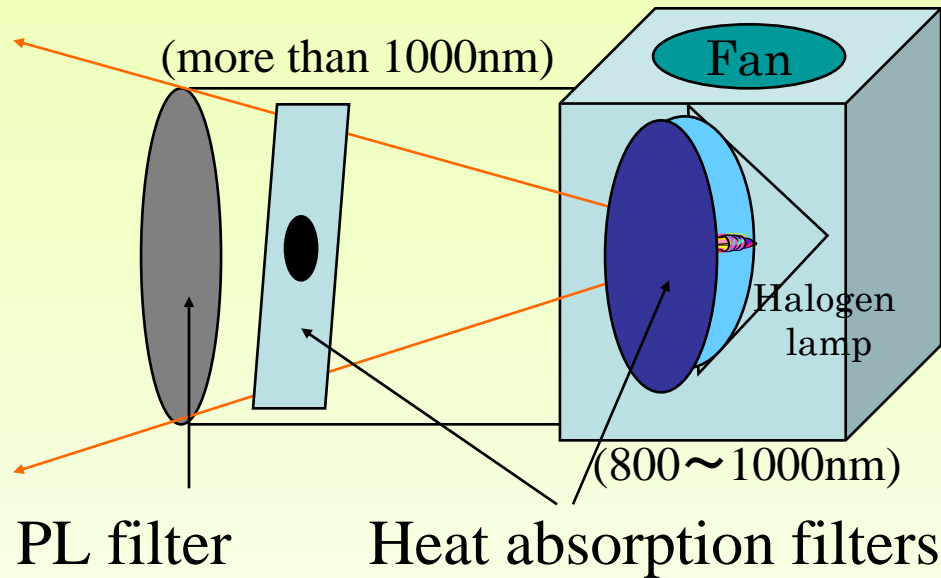
- To investigate relation between cuticular layer and fruit surface gloss
- To investigate effectiveness of PL filtering image compared with conventional dome and diffuser-used images



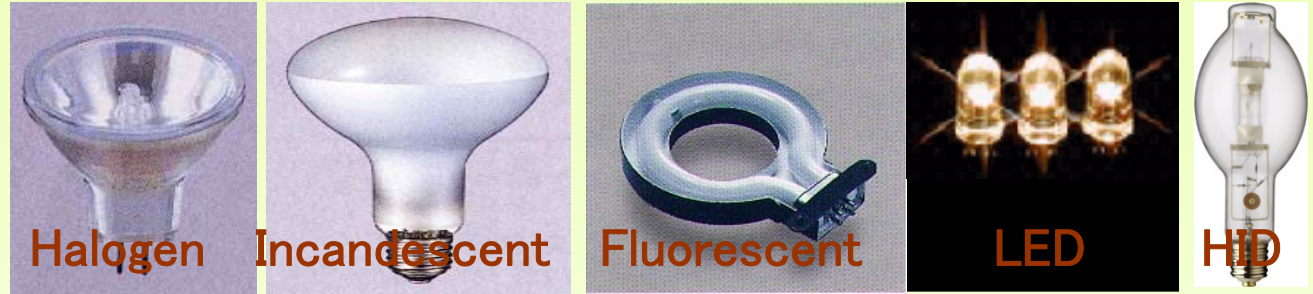
Indirect lighting devices (Dome and Diffuser)



Direct Lighting Device with PL filter



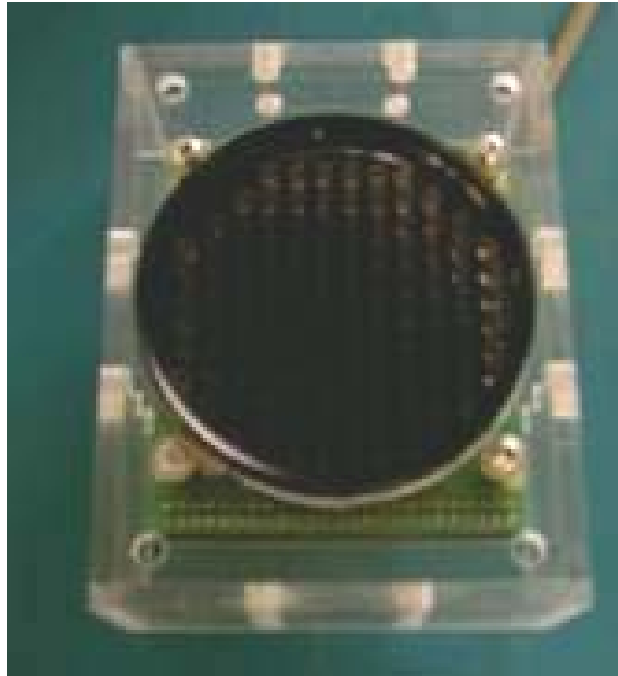
Comparison of lamps



Brightness	High	Mid	Low	Low	High
Color rendering	High	High	Low	Mid	Mid
Lumen	High	High	Mid	High	Low
Maintenance					
Life	Mid	Short	Mid	Long	Long
Price	Low	Low	Mid	High	High



Direct lighting device with LEDs



120 white LEDs



Easy control: Quick Response for input signal

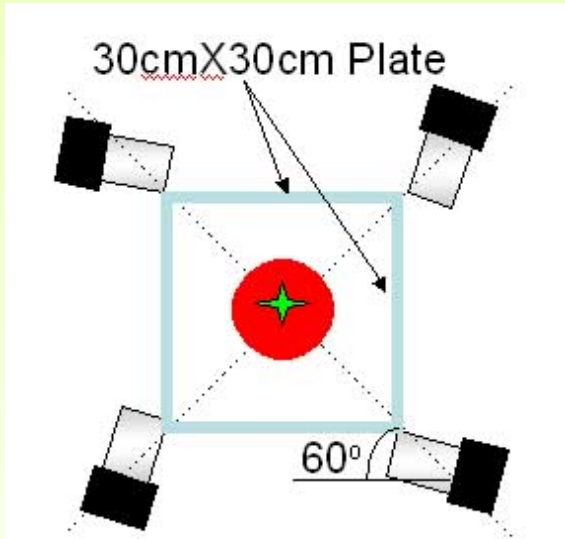


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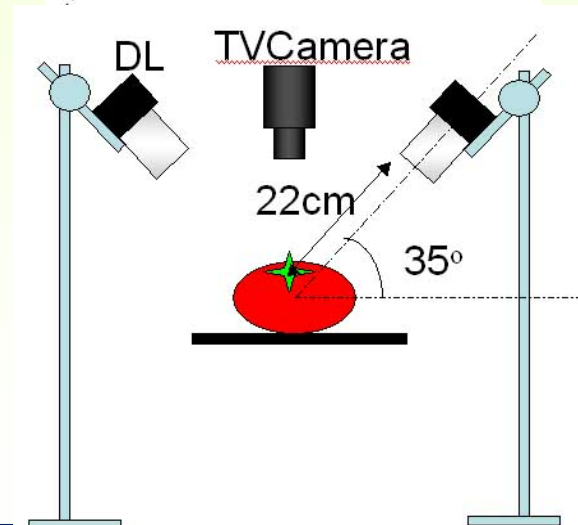
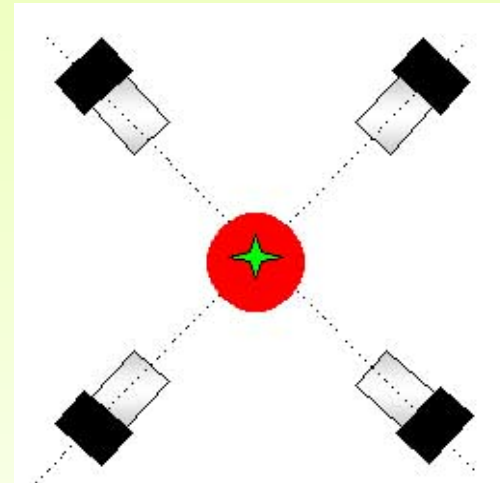
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Lighting Device Arrangement

Arrangement 1
(Dome walls and 4 DLs)



Arrangement 2 and 3
(Diffusers or PL filters and 4 DLs)



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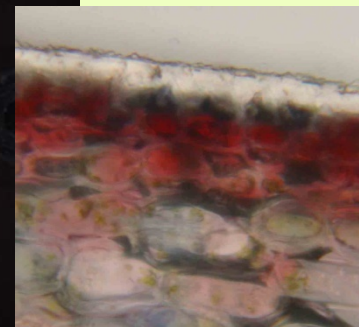
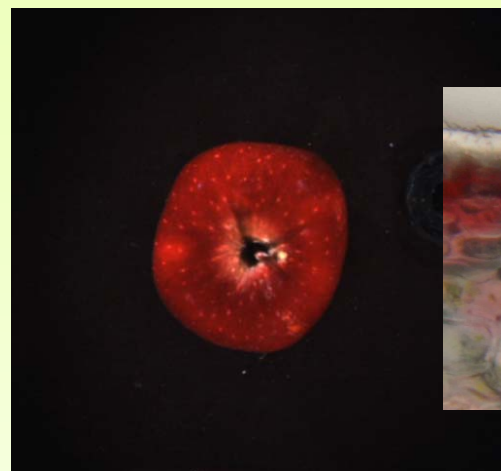
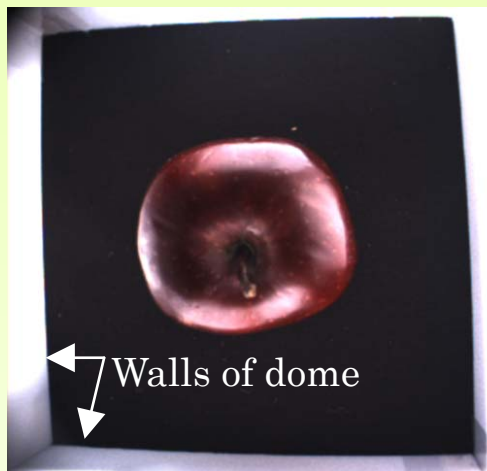
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Materials

- **category 1** (glossy surface fruits:
apples, tomato, eggplant, pepper, lemon)
- **category 2** (short hair fruits or powdery
fruits:
kiwi, peach, pear, banana)
- **category 3** (root vegetables:
potato, Daikon radish)



Category 1 (Smooth and thick cuticle)



Apple



Eggplant

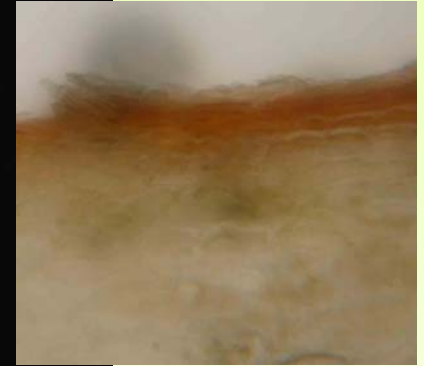
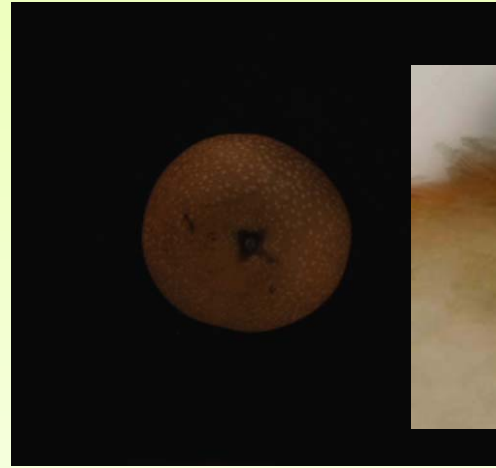
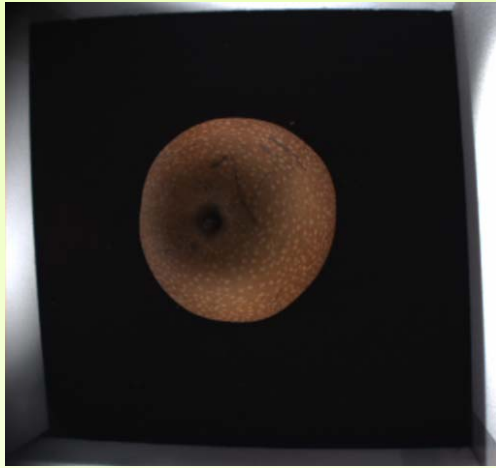
Dome

Diffuser

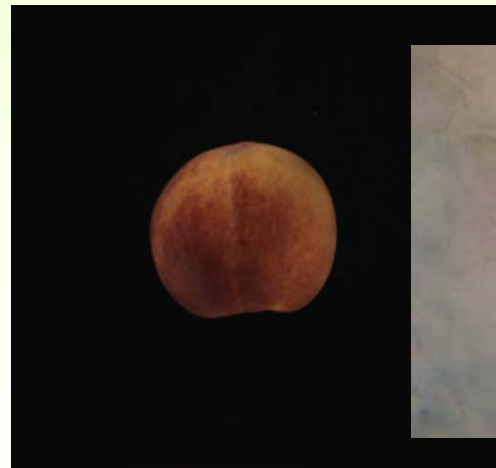
PL filter



Category 2 (Rough cuticle)



Pear



Peach

Dome

Diffuser

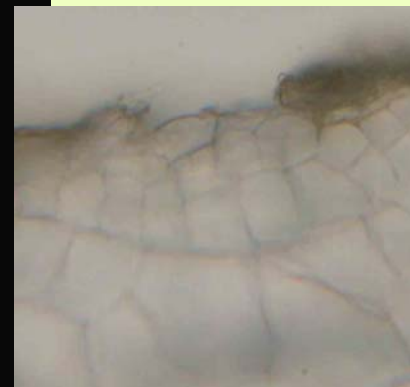
PL filter



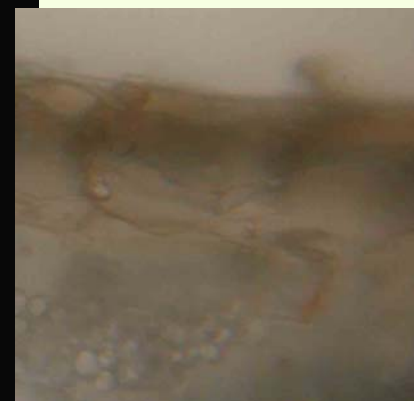
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Category 3 (No cuticle)



Daikon radish



Potato

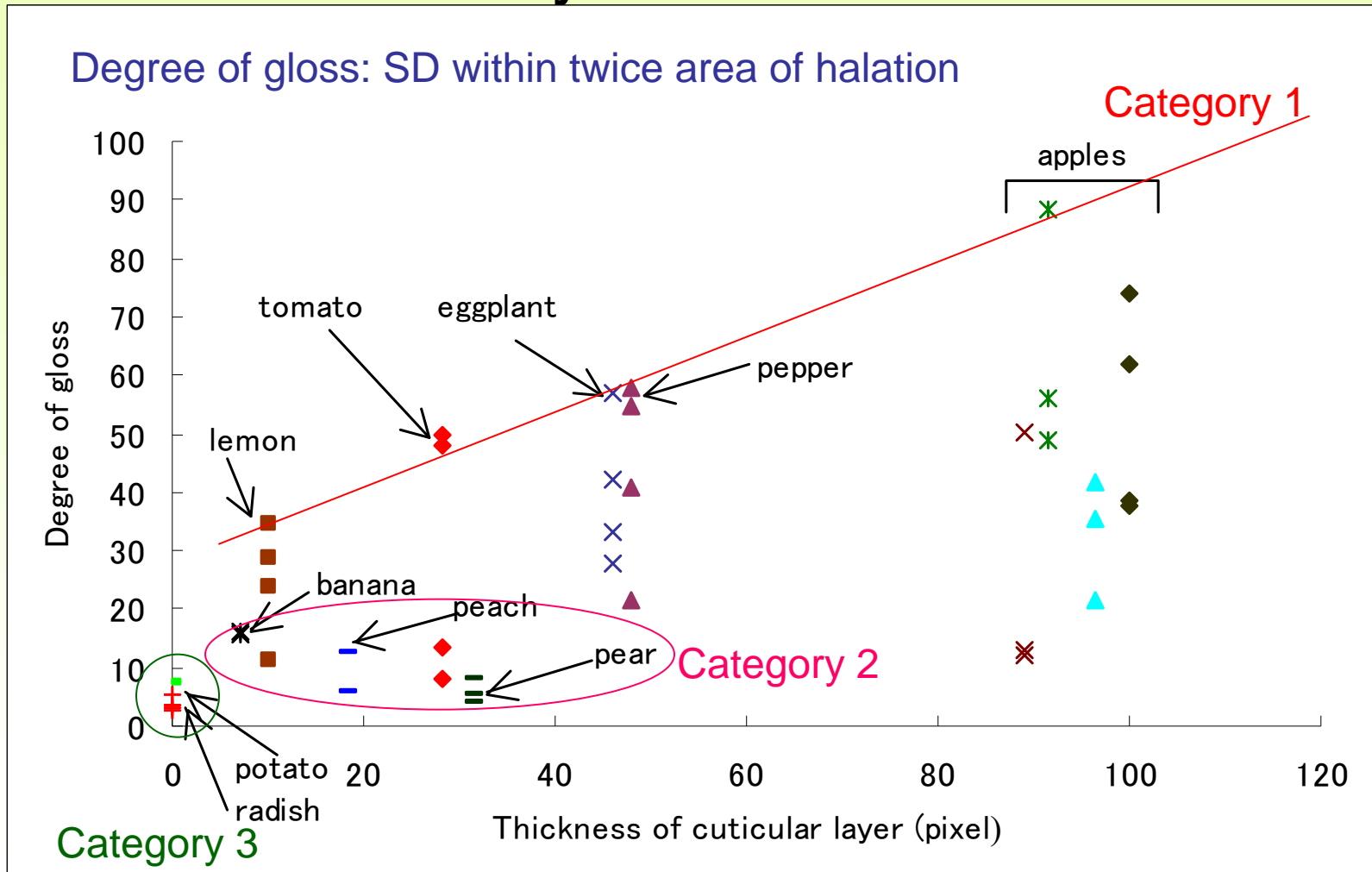
Dome

Diffuser

PL filter



Relation between degree of gloss and cuticular layer thickness



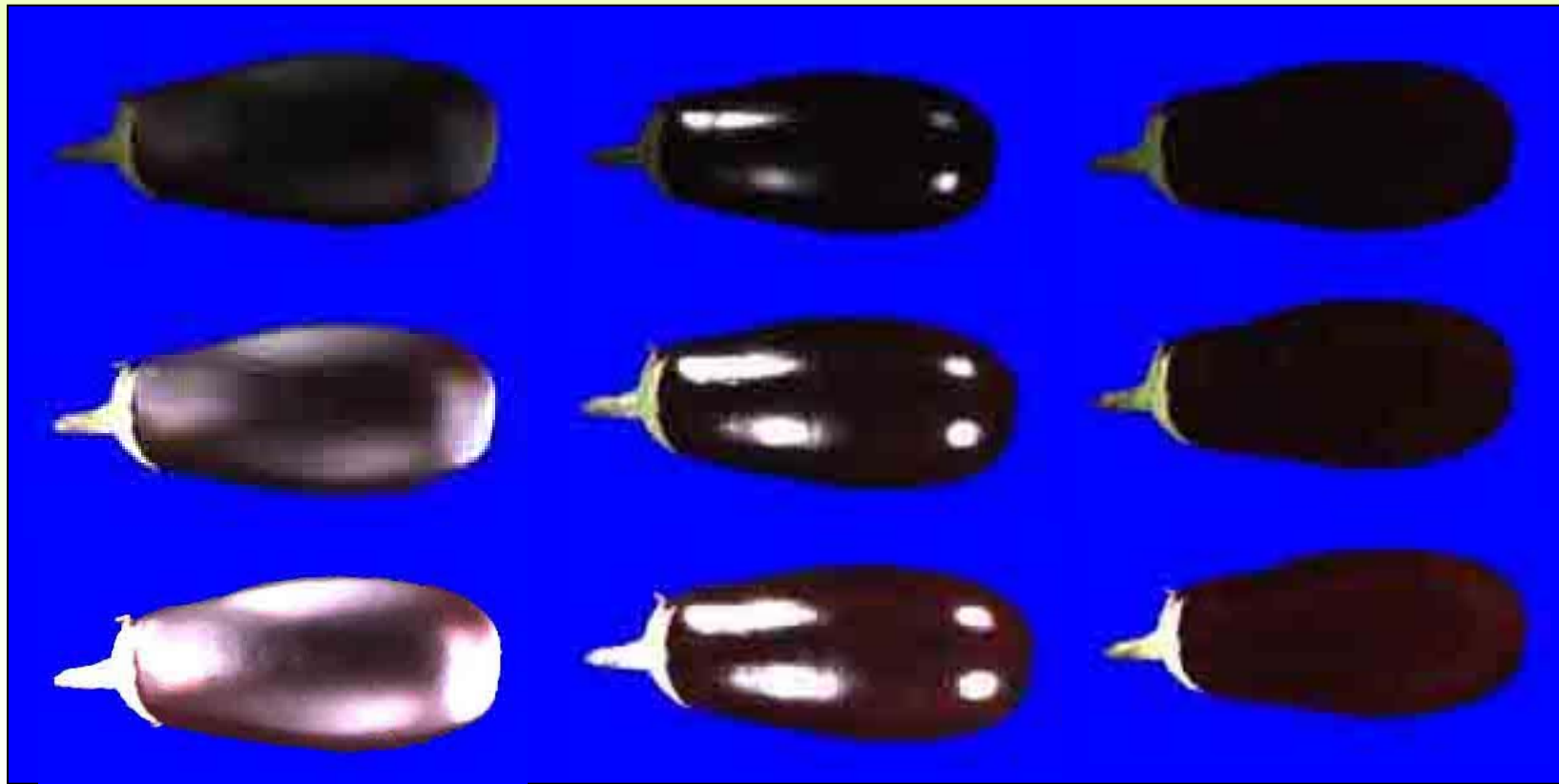
(100 pixels is almost 25 μm .)



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Images on different exposure conditions



Exp.1
(dark)

Exp.2
(mid)

Exp.3
(bright)

Dome

Diffuser

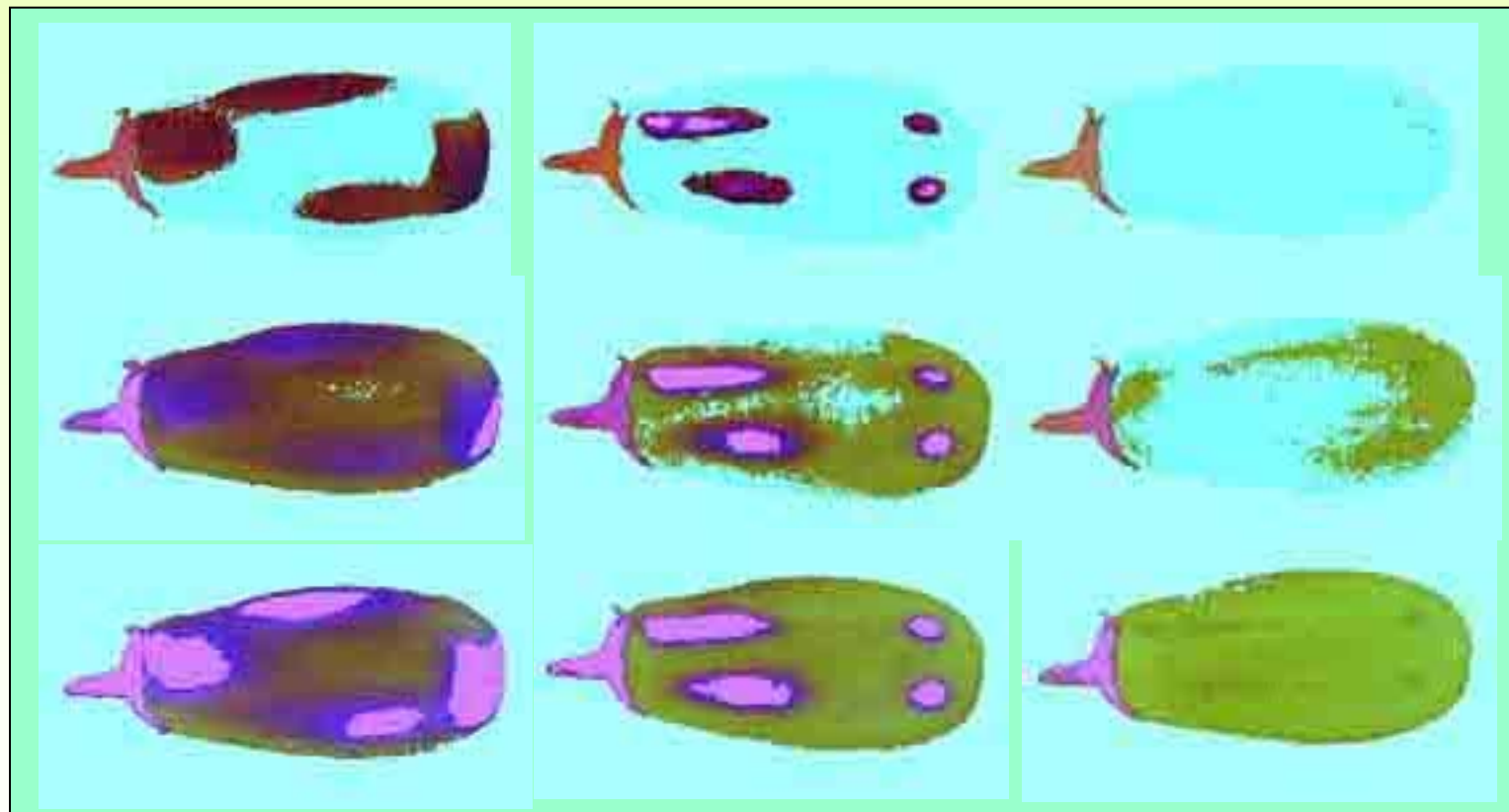
PL filter



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HSI on different exposure conditions



Exp.1
(dark)

Exp.2
(mid)

Exp.3
(bright)

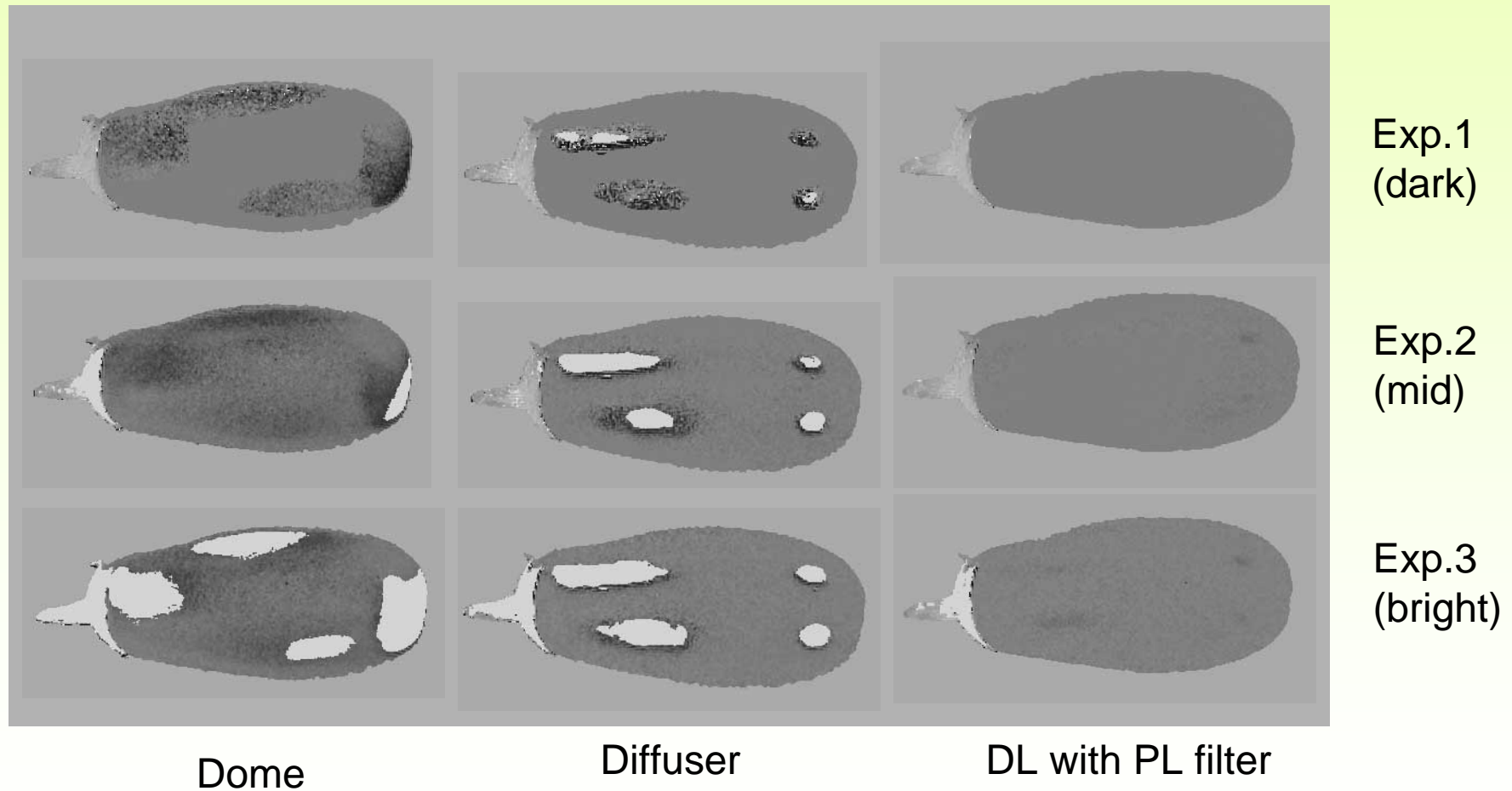
Dome

Diffuser

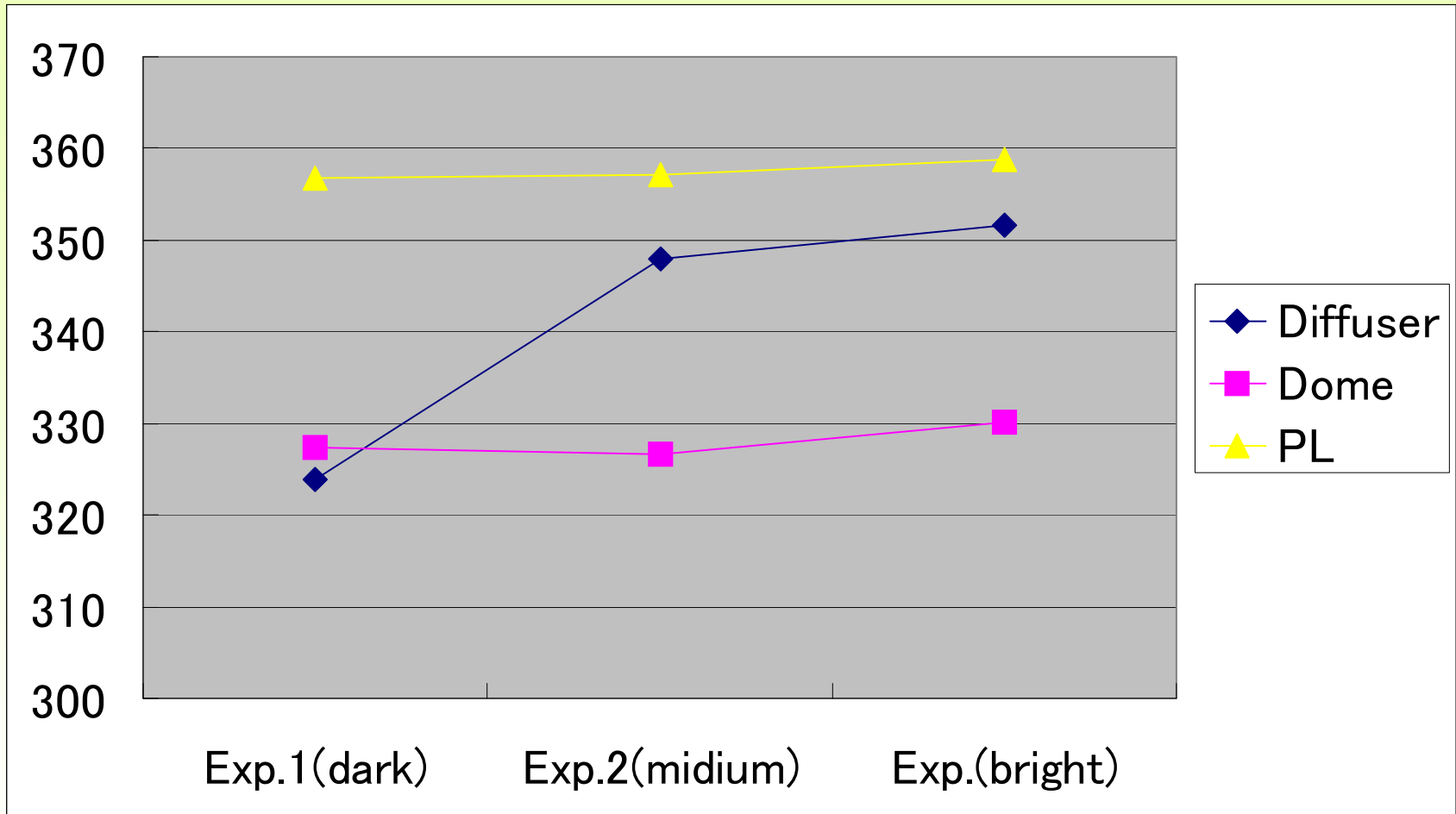
PL filter



Hue

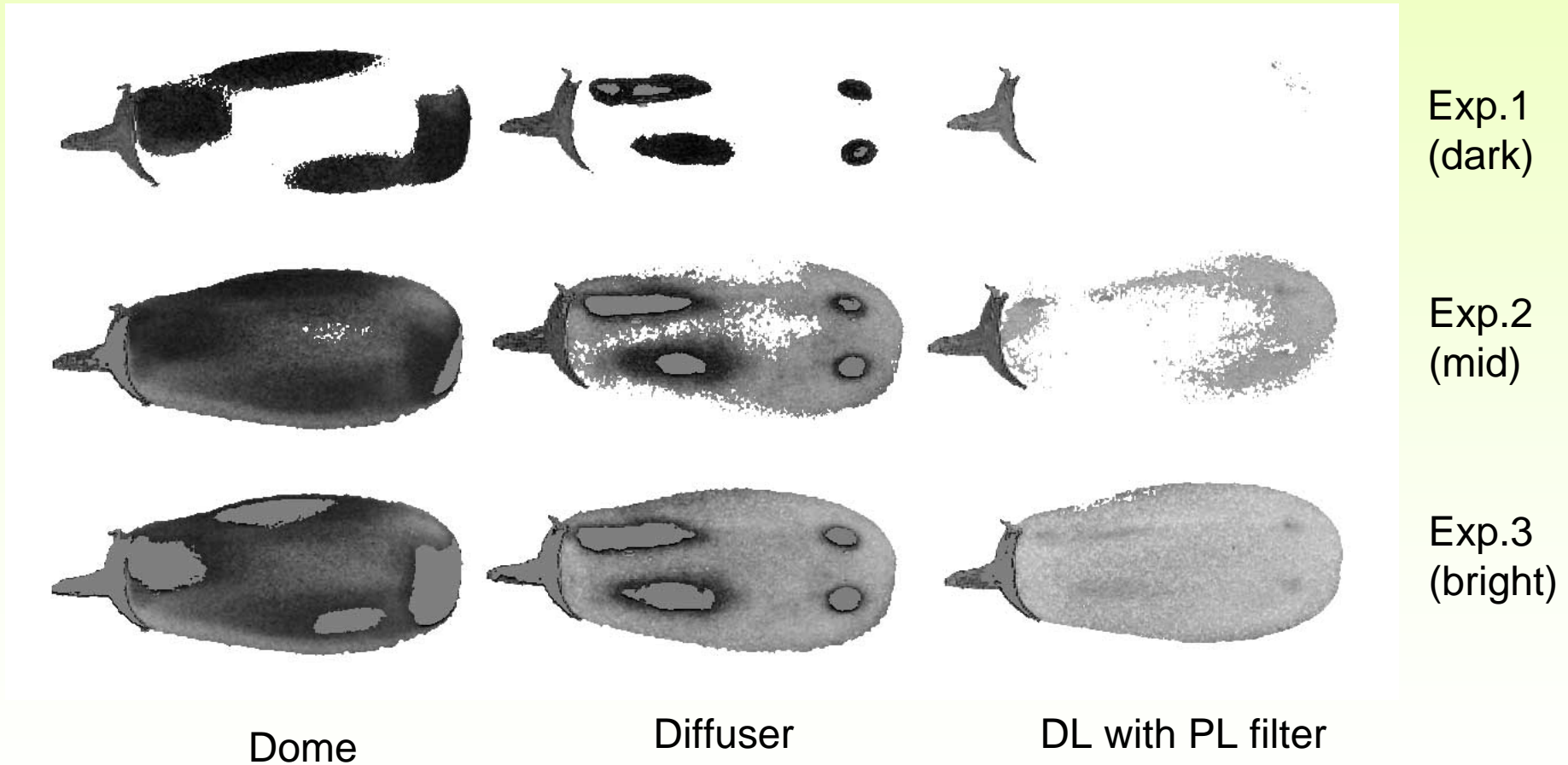


Hue on different exposure conditions

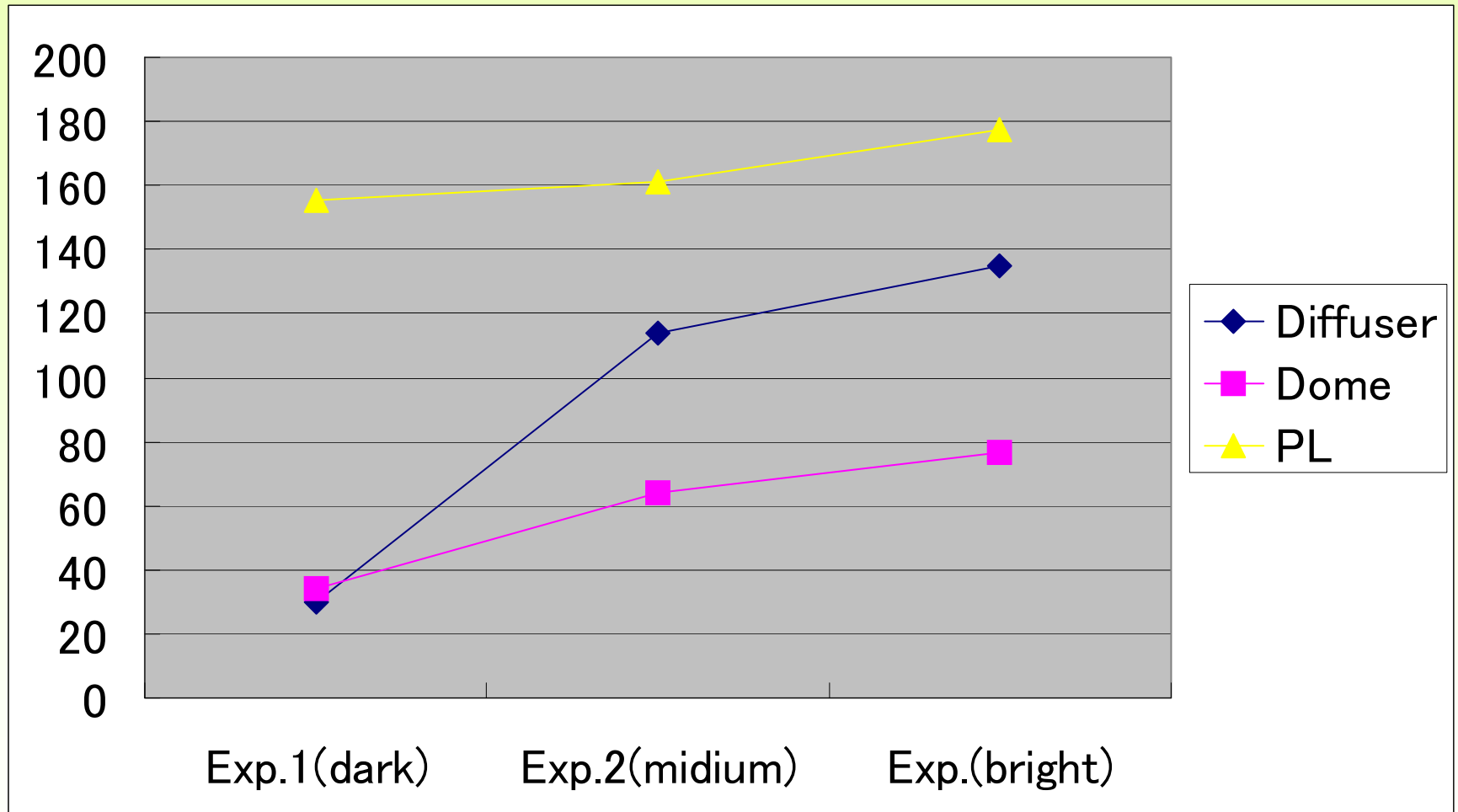


(Average hue value change except too bright and too dark pixels)

Saturation



Saturation on different exposure conditions



(Average hue value change except too bright and too dark pixels)



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Conclusion

- Degree of gloss (halation) on fruit had proportional relation with thickness of cuticular layer.
- PL filtering image had higher color reproduction compared with diffuser or dome.
- Dome made larger low saturation area.

