Super-Efficient Coloured PV for Vehicles

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Solar car possibility

- **Add range above 30km per day**
- **Affordable cost (Lightyear 2 ~ Tesla Model 3)**
- **Inevitable trend of electric vehicles**

- **PROBLEM: unpleasant aesthetic appearance**

SOLAR CAR NEEDS COLORS

Lightyear, solar cell may add 50km per day

Sunswift UNSW, may add 100km of range on a sunny day

Tesla solar car, reduce charging price by 50%

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Colored solar cells

$$J(V) = J_{ph} - J_{rec}(V)$$

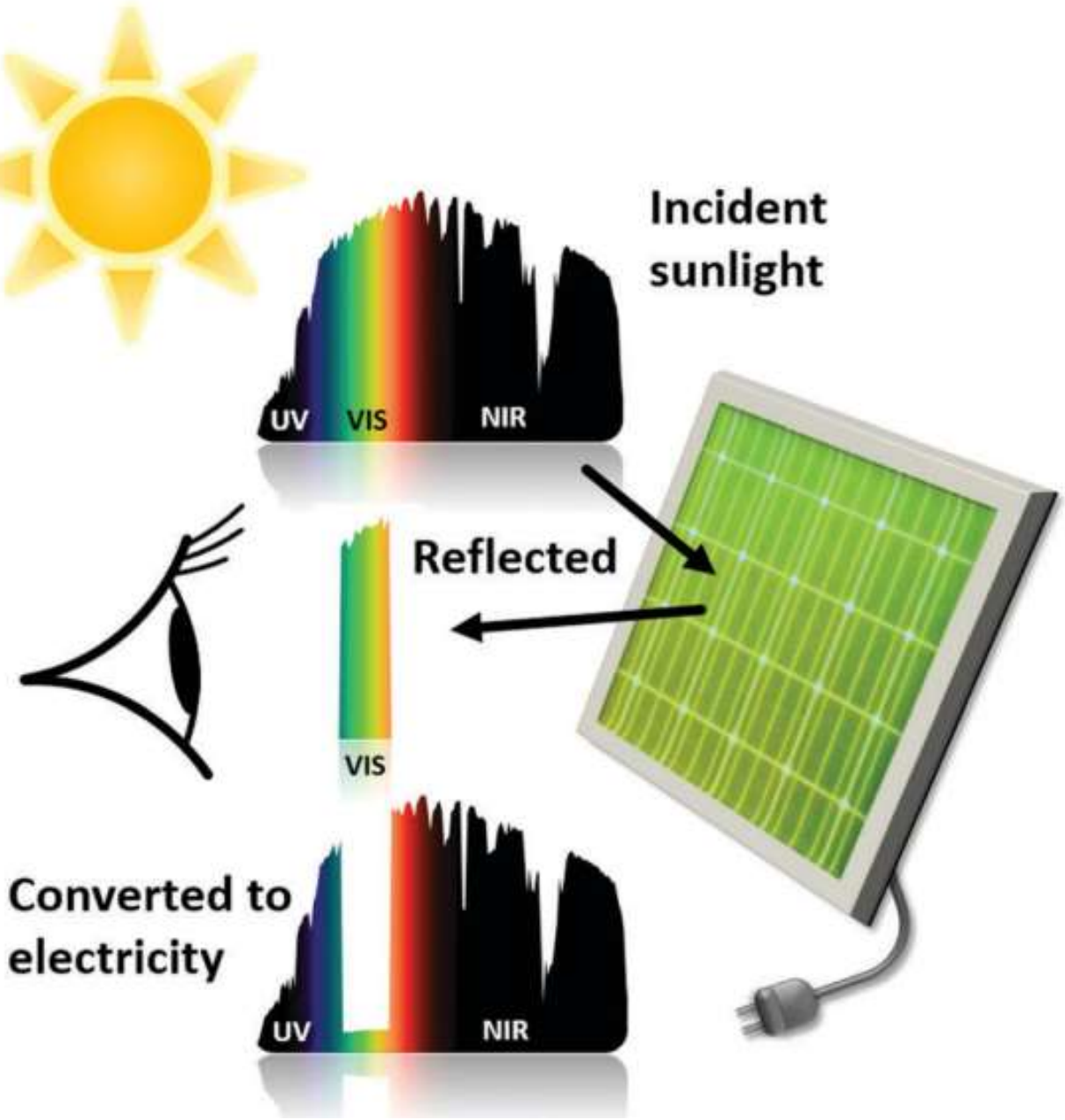
$$J_{ph} = q\int_0^{\lambda_g} EQE(\lambda)S(\lambda)d\lambda$$

$$EQE(\lambda) = \begin{cases} 1 - R(\lambda), & 0 < \lambda \le \lambda_g \\ 0, & \lambda > \lambda_g \end{cases}$$

$$J_{rec}(V) = J_{rec0}\left(e^{\frac{qV}{kT}} - 1\right)$$

$$J_{rec0} = rqp_{rad0}$$

$$p_{rad0} = \frac{2\pi}{h^3c^2}\int_{E_g}^{\infty}[1 - R(\lambda)]E^2e^{-\frac{E}{kT}}dE$$



- J_{sc} will be reduced
- V_{oc} may be enhanced

Energy Environ. Sci., 2019, 12, 1274--1285

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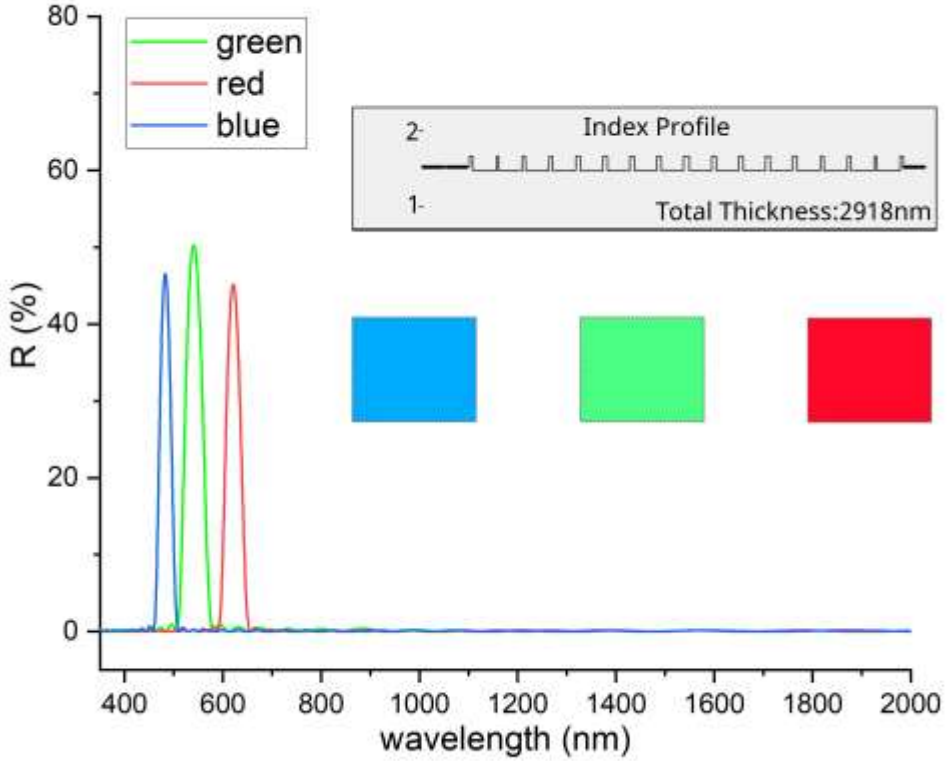
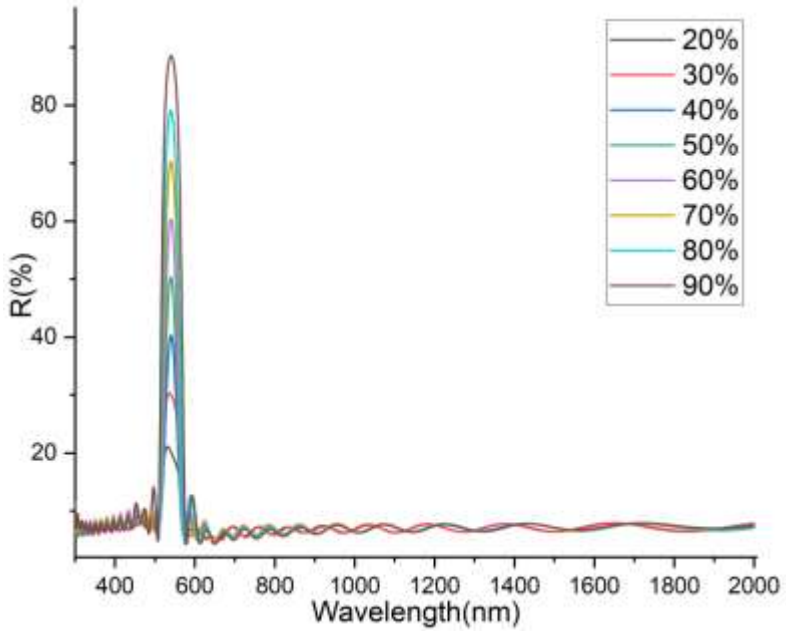
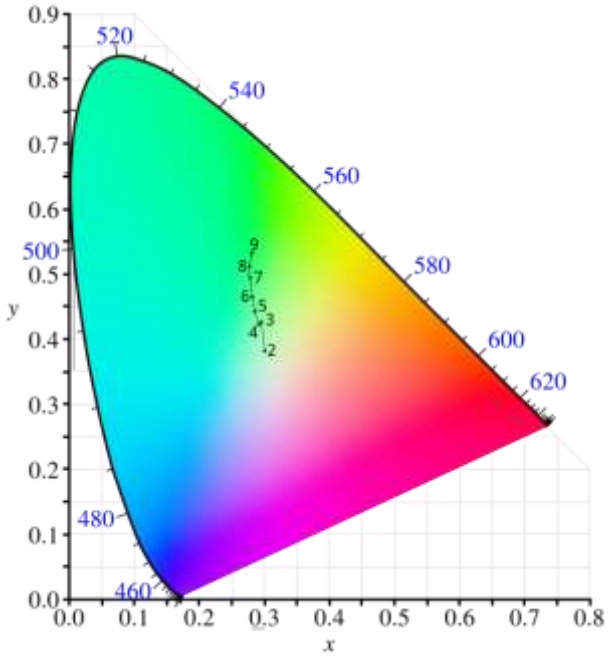
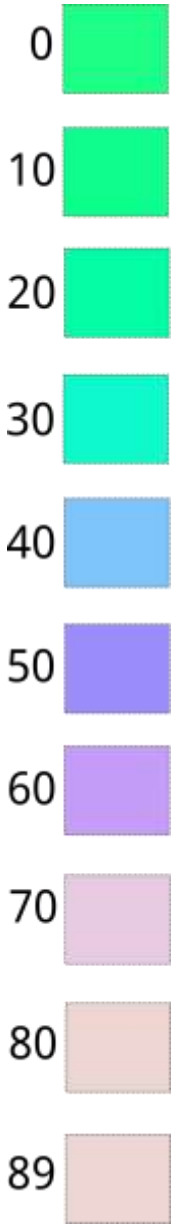
Optical notch filter







Angle-Color



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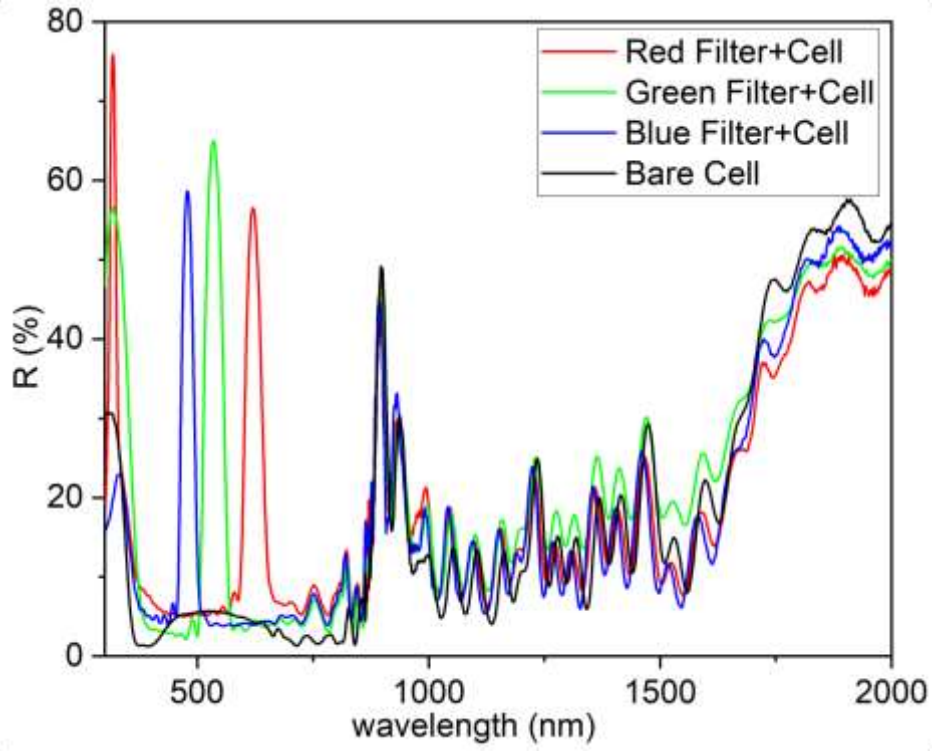
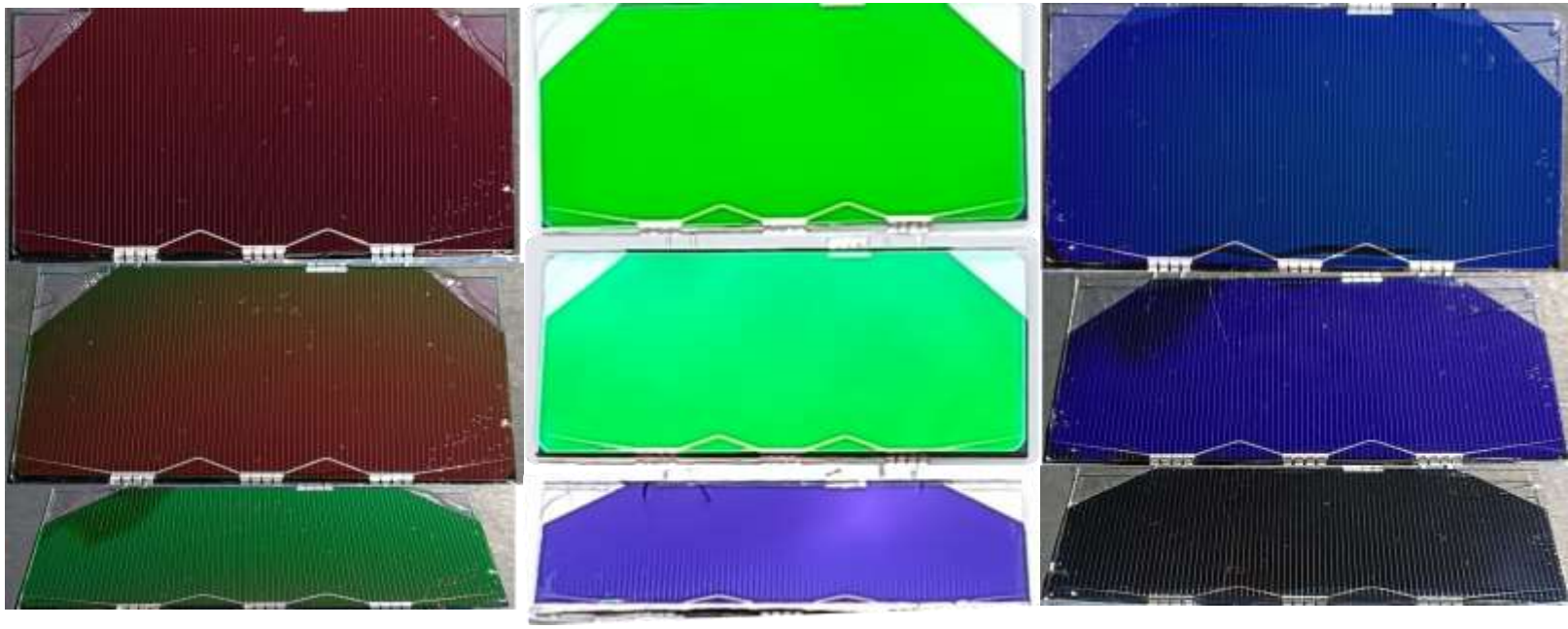
Colored III-V

Why III-V: Add more range to EV

Mass production price is affordable for EV





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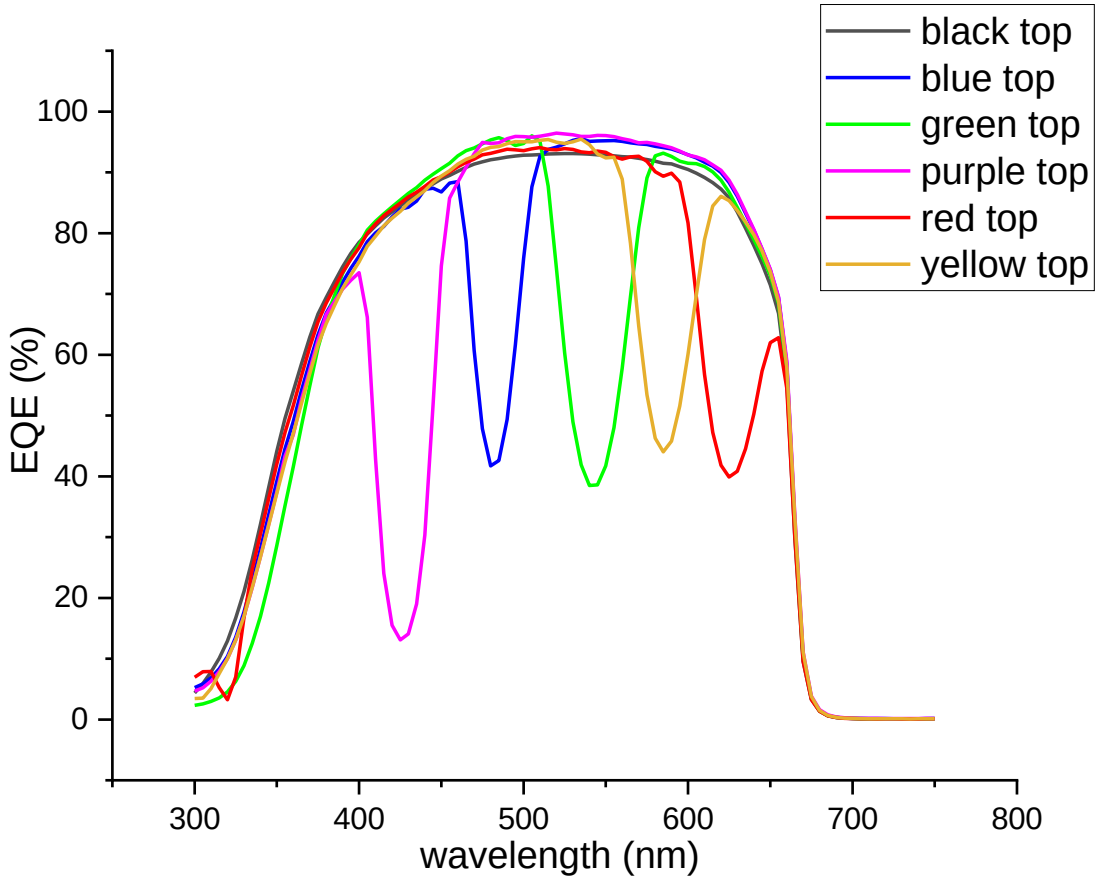
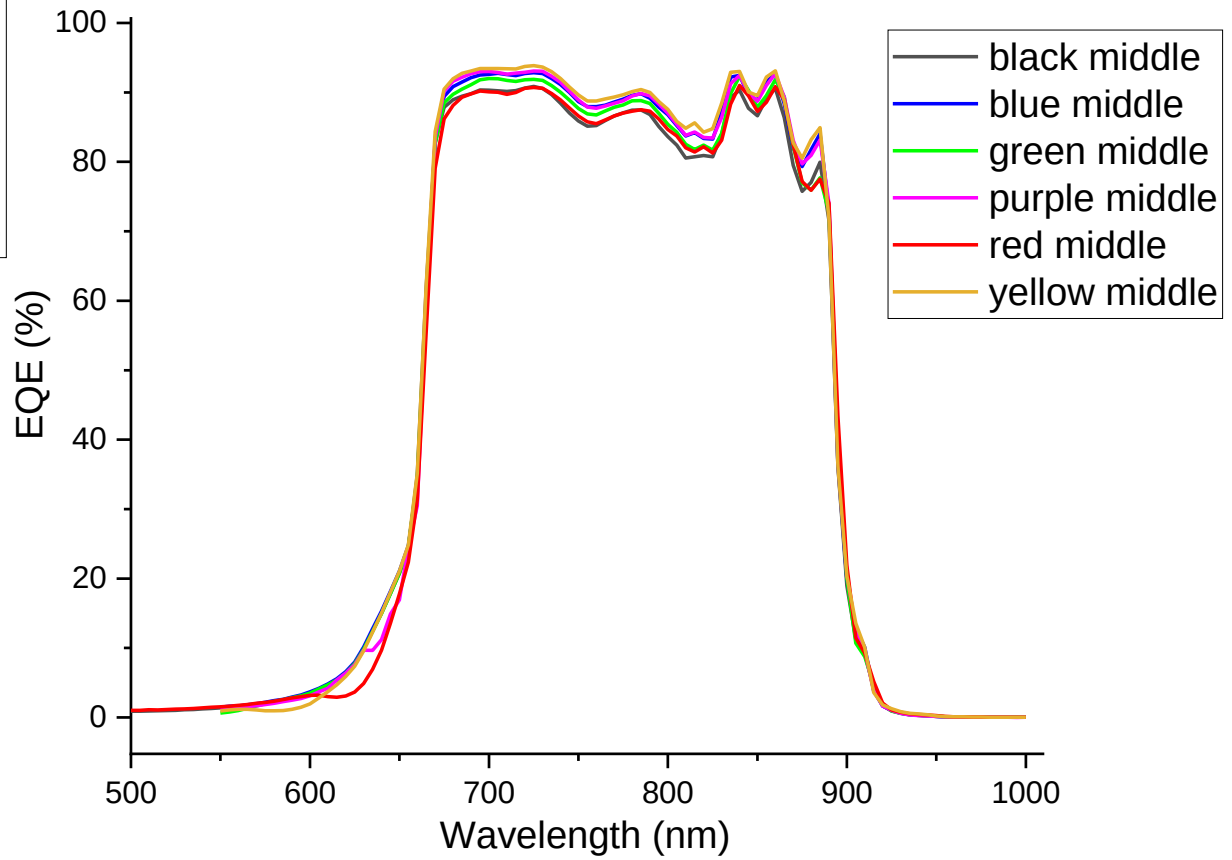
EQE





Filters impact on top cells only

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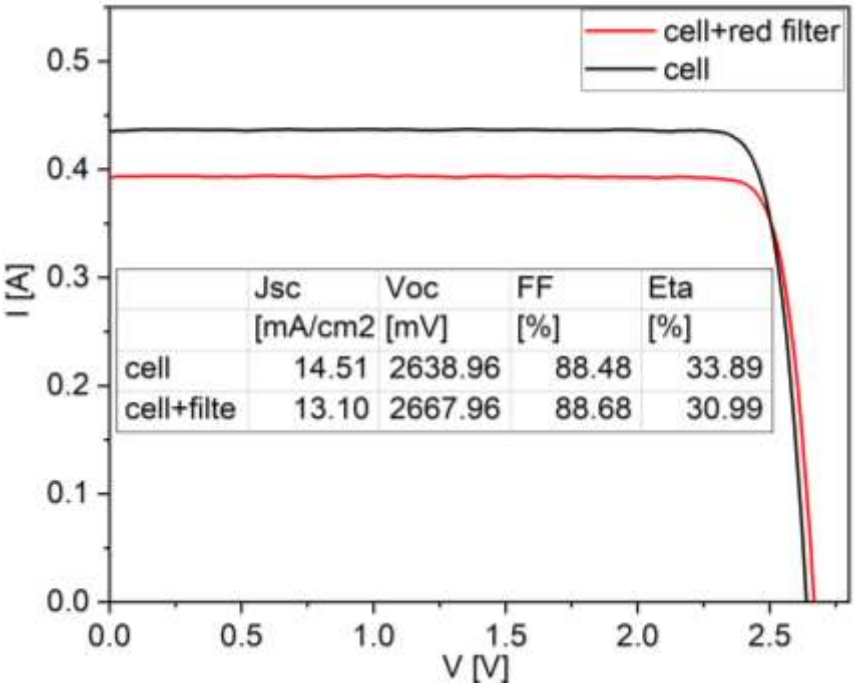
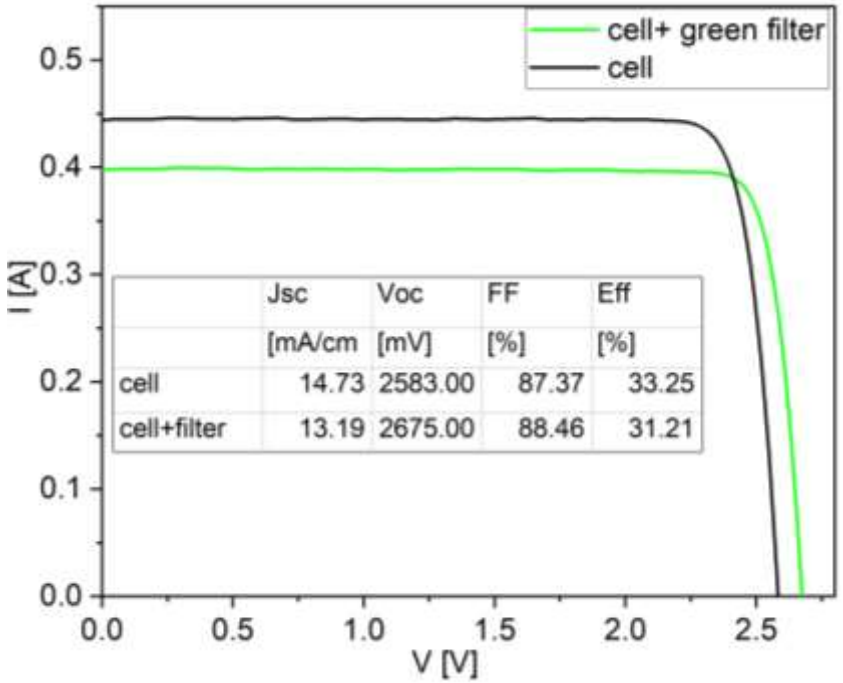
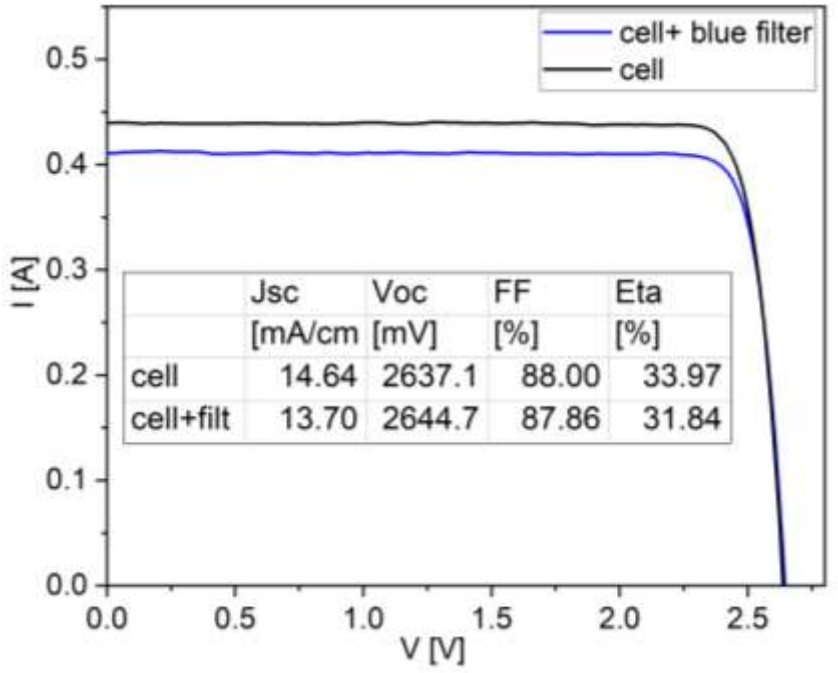
Indoor I-V curves



	Jsc [mA/cm2]	Voc [mV]	FF [%]	Eta [%]
cell	14.51	2638.96	88.48	33.89
cell+filte	13.10	2667.96	88.68	30.99



	Jsc [mA/cm	Voc [mV]	FF [%]	Eff [%]
cell	14.73	2583.00	87.37	33.25
cell+filter	13.19	2675.00	88.46	31.21



	Jsc [mA/cm	Voc [mV]	FF [%]	Eta [%]
cell	14.64	2637.1	88.00	33.97
cell+filt	13.70	2644.7	87.86	31.84

Only ~2% loss at one sun illumination

I_{sc} drops by ~40mA

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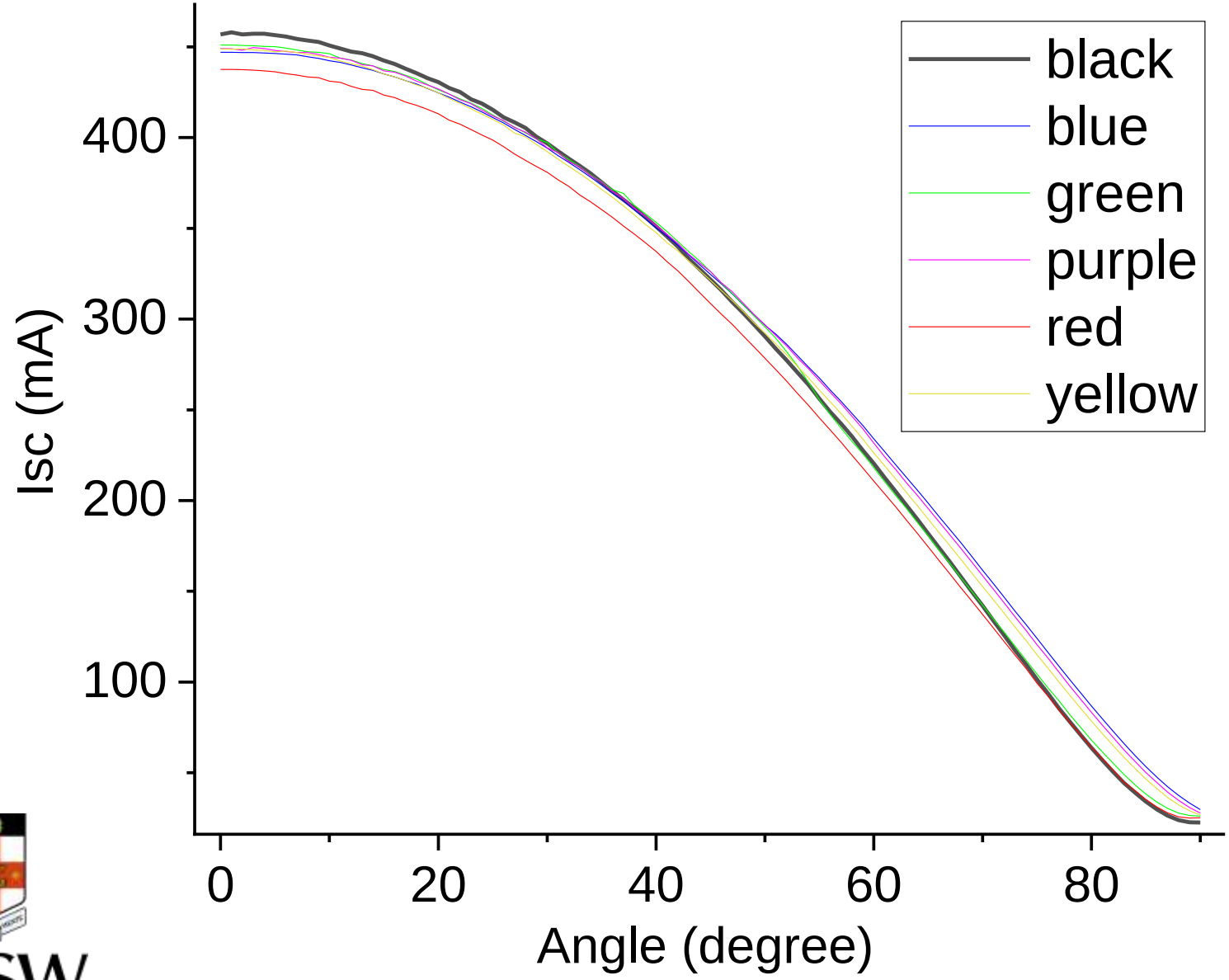
Outdoor angular I_{sc}



I_{sc} drops by 10~20mA at normal incidence

Outdoor cell performance is less affected due to stronger diffusive lights

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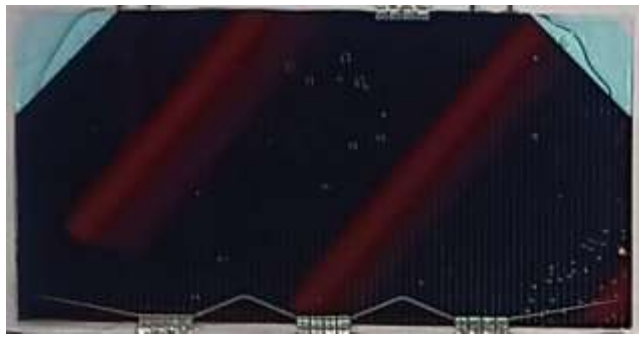
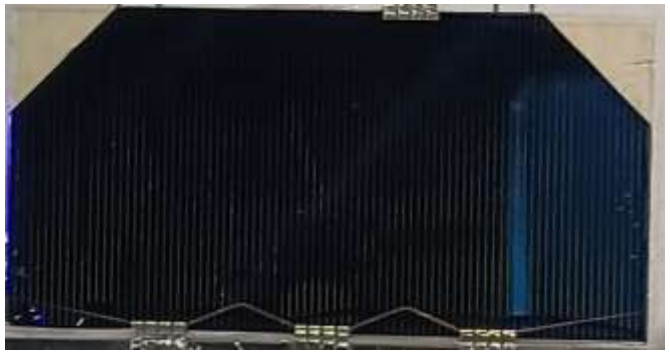
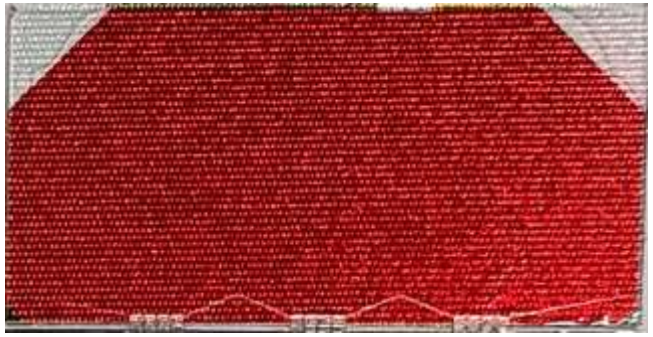
Scattering effects



Add luxury effects and enhance colors at weak and indoor illumination

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Future works

Solution-based optical filter growth, like sol-gel growth, LB method

Glass surface structures to minimize angular dependence

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Thank you

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