Hybrid fluorescent protein-polymer derivatives for stable deep-red lighting devices

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Recent progress in the field of bio-hybrid light-emitting diodes (Bio-HLEDs) have shown mCherry fluorescent protein as the main candidate for highly stable deep-red devices. We recently revealed that the deactivation mechanism of mCherry embedded in polymer matrices is highly dependent on oxygen permeability and residual water content upon preparation.[1] Here, we report a mCherry functionalization with hydrophilic polymer chains as a strategy to reduce the chromophore deactivation pathways by *i*) acting as a protective shell and *ii*) potentially reducing the H-transfer driven chromophore protonation resulting in emission quenching. First, we ruled out the effect of the chain length on the stability of the FP inside reference coatings upon mild continuous irradiation conditions (55 mW cm^{-2}). Secondly, we refined the overall device performance through the stabilization of the best performing hybrid mCherry-polymer adduct in previously reported PVA-based matrix, preparing first class deep-red Bio-HLEDs (*x/y* CIE color coordinates of 0.6/0.3) stable >200 h upon harsh driving conditions (600 mA, 150 mW cm^{-2}). This overcomes the prior art for mCherry-based Bio-HLEDs (50/~15 h at 55/150 mW cm^{-2}).[1, 2] Thus, this work not only *i)* identifies a novel strategy to protect low-energy emitting proteins from the detrimental effect of the environment in solid state upon irradiation stress, but also *ii)* settles record performances in the field of deep-red Bio-HLEDs.

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Hasler, M., Patrian, M., Banda-Vázquez, J. A., Ferrara, S., Stiel, A. C., Fuenzalida-Werner, J., Costa, R. D., *Adv. Funct. Mater.* **2023**, 2301820.