

Supplementary Information

on

Photocatalytic hetero-nanostructures by integrating multicomponent Cu₂O-Au nanoparticles into ZnO-coated butterfly wings colored by photonic nanoarchitectures

by

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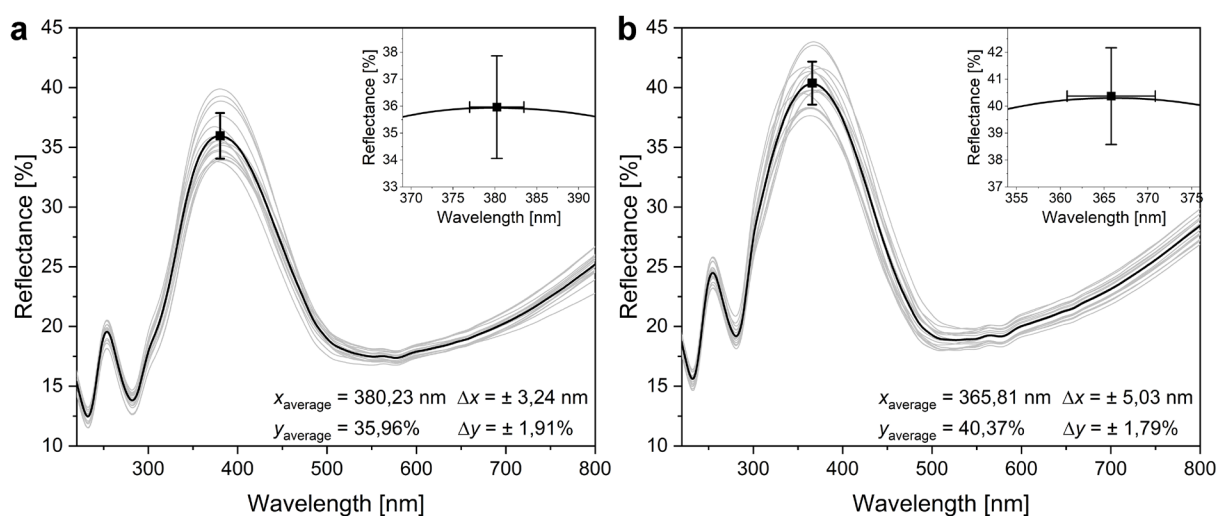


Figure S1. Changing spectral properties induced by the 50 °C ethanol pretreatment of 40 male *Polyommatus icarus* wings. Samples were measured (a) before and (b) after the ethanol treatment. The insets show the peak wavelength area magnified.

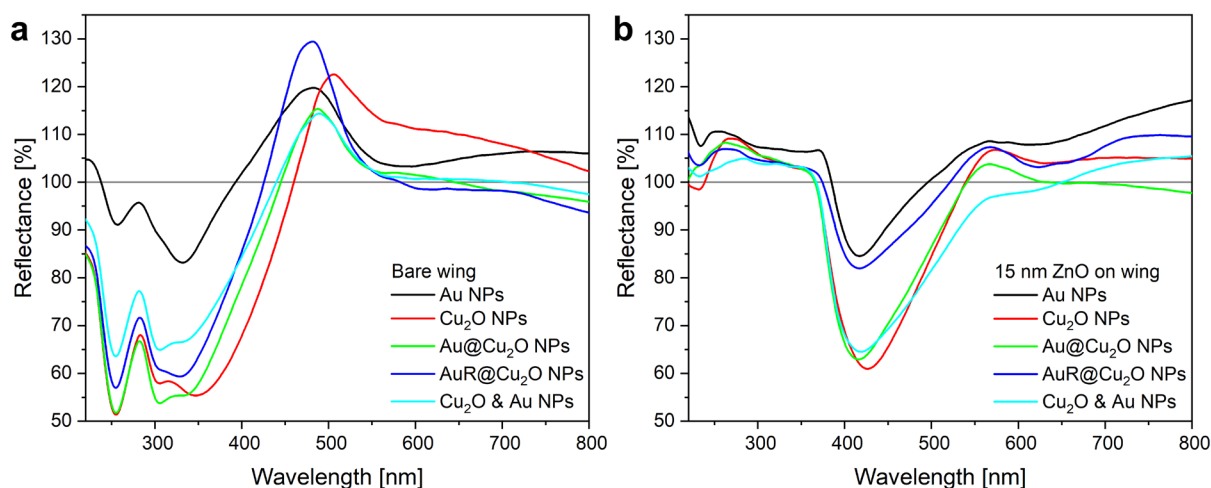


Figure S2. Relative reflectance spectra of the butterfly wings with the deposited NPs with respect to their initial reflectance before the deposition. The presented curves are the averages of three distinct samples measured. (a) Uncoated wings and (b) 15 nm ZnO coated wings are shown.

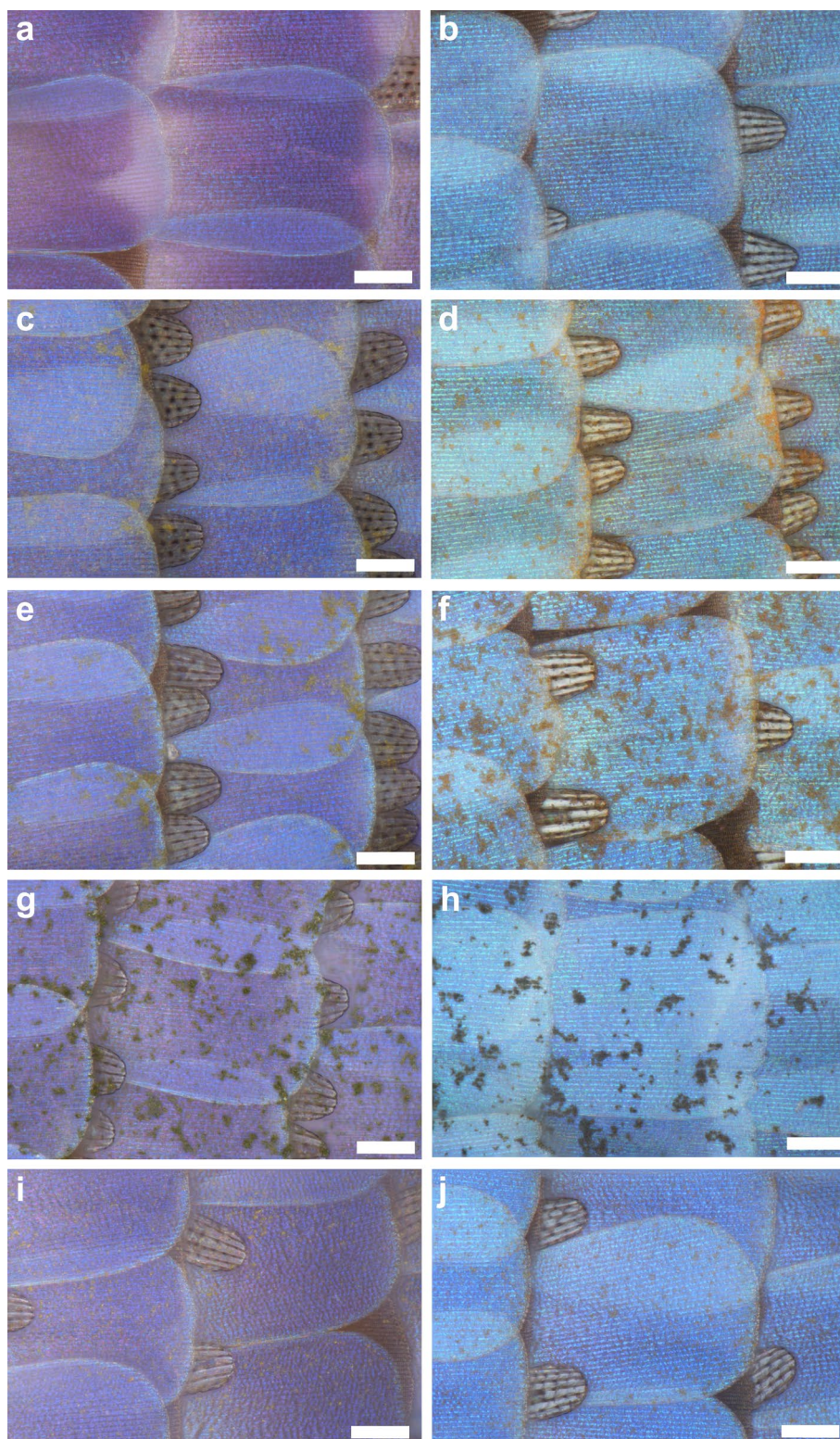


Figure S3. Focus stacking microscope images of wing scales after the deposition of Au NPs to (a) bare and (b) 15 nm ZnO wings; Cu₂O NPs to (c) bare and (d) 15 nm ZnO wings; Au@Cu₂O NPs to (e) bare and (f) 15 nm ZnO wings; AuR@Cu₂O NPs to (g) bare and (h) 15 nm ZnO wings; Cu₂O NPs and Au NPs to (i) bare and (j) 15 nm ZnO wings. Scale bars: 20 μm.

Figure S4. Reflectances and relative reflectance curves for butterfly wings before and after the deposition of drop-casting of NP sols. Samples **(a)** before and **(b)** after the post-deposition of 5 nm of ZnO on the NP-deposited samples are shown.

Figure S5. Reflectances and relative reflectance curves for butterfly wings with 15 nm ZnO coating before and after the drop-casting of NP sols. Samples (a) before and (b) after the post-deposition of 5 nm of ZnO on the NP-deposited samples.

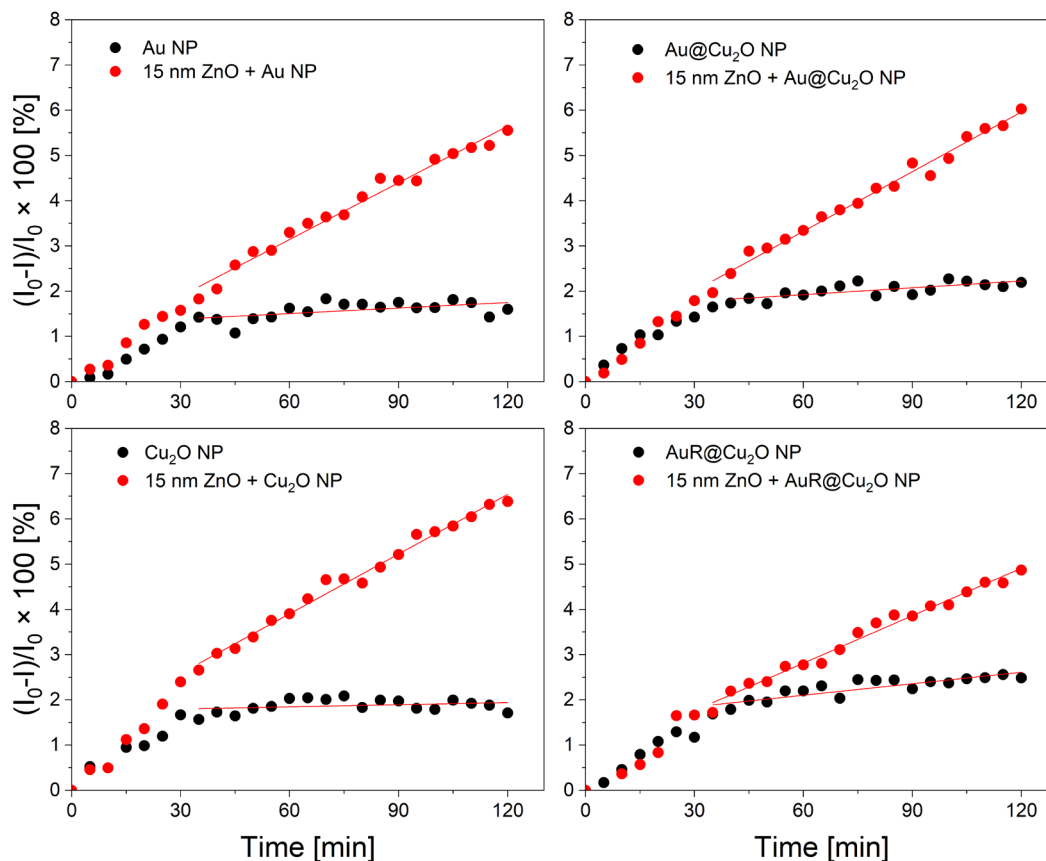


Figure S6. Conversion vs. time plots of the photodegradation process of MO under visible light illumination on the wings modified as indicated in the legends. Fitted lines were converted to initial rate values as given in Table 2 and appear in Figure 7. Reaction conditions are found in the Materials and methods. Note that the initial, less than 2% conversion includes an apparent component. It is due to thermal equilibration in the cell upon irradiation. This phenomenon causes a temperature change that affects the optical properties and the observed absorbance, an intrinsic property of the test system.

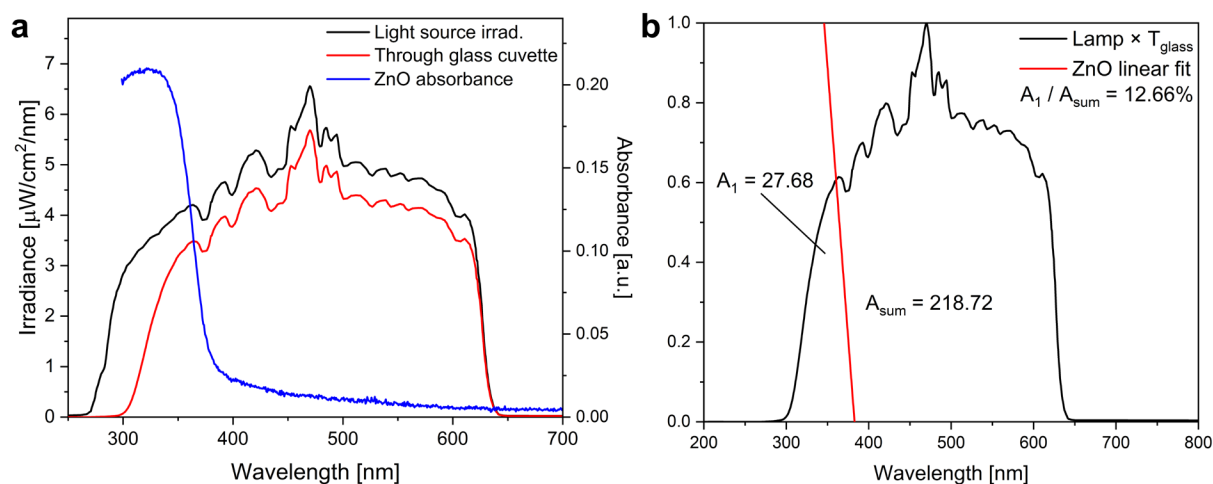


Figure S7. Irradiance of the light source used and the measured absorption of the 15 nm ZnO layer deposited on flat glass. **(a)** Light source irradiance and the irradiance calculated with the measured transmittance of the used glass cuvette; **(b)** normalized irradiance plot with the calculated absorption edge of the deposited ZnO. Note that in **(a)**, the low absorption in the 380–700 nm range is due to defects in the ZnO thin film. As such its contribution to the photocatalytic process is negligible.

Table S1. Sample modification details and photocatalytic activity of the fabricated reference samples without any deposited NPs.

Sample name ^b	Wing type	Deposition 15 nm ZnO	Reaction rate [nmol/min]	Standard deviation [nmol/min]
Glass (G0)	-	no	0.05	0.01
G0 + PMMA	-	no	0.04	0.03
Flat G15	-	to glass	0.03	0.01
Rough G15	-	to glass	0.19	0.06
W15 on flat G0	ETA50	to wing	0.08	0.04
W15 on rough G0	ETA50	to wing	0.07	0.03

^b sample naming: G0 designates untreated glass substrate, + PMMA with adhesive layer, G15 designates 15 nm ZnO thin film on flat of roughened glass substrate, W15 designates 15 nm conformal ZnO coating on the wing after the ETA50 treatment on flat or roughened glass.