Radiolytic Synthesis of rGO-PEDOT Nanohybrids with Enhanced Functional Properties

Souad Abou Zeid.[a*] Liran Hu.[a] Rasta Ghasemi.[b] Matthieu Gervais.[c] Jaspreet Kaur Randhawa.[d] Prem Felix Siril [e]

[a.] *Institut de Chimie Physique, ICP, UMR 8000, CNRS, Université Paris-Saclay, bâtiment 349, Campus d'Orsay, 15 avenue Jean Perrin, 91405 Orsay Cedex, France.*
[b.] *Institut d'Alembert, IDA, ENS Paris-Saclay, 4 avenue des sciences, 91190 Gif-sur-Yvette, France.*
[c.] *Laboratoire Procédés et Ingénierie en Mécanique et Matériaux, PIMM, Arts et Métiers ParisTech, UMR 8006, CNRS, CNAM, HESAM université, 151 boulevard de l'hôpital, 75013 Paris, France.*
[d.] *School of Mechanical and Materials Engineering, Indian Institute of Technology Mandi, Mandi-175005, Himachal Pradesh, India*
[e.] *School of Chemical Sciences, Indian Institute of Technology Mandi, Mandi, Himachal Pradesh-175005, India.*
[f.] *Département Chimie Vivant Santé, EPN 7, Conservatoire National des Arts et Métiers, CNAM, 292 rue Saint-Martin, 75141 Paris Cedex 03, France.*
[*] *Corresponding author. Institut de Chimie Physique, ICP, UMR 8000, CNRS, Université Paris-Saclay, bâtiment 349, Campus d'Orsay, 15 avenue Jean Perrin,91405 Orsay Cedex, France. E-mail address: samy.remita@universite-paris-saclay.fr (S. Remita), souadabouzeid321@gmail.com (S. Abou Zeid).*

and Samy Remita [a.f *]

Supporting information

Table S1 Nomenclature of Samples Synthesized According to the three different procedures

Series	Sample Name	Absorbed dose (kGy)	Initial Composition	Notes/Description
①	**GO-E (0 kGy)**	0	[GO] = 1.42 g L^{-1}, [EDOT] = 10 mM, [IPA] = 0.2 M	Unirradiated control
	rGO-P (20 kGy)	20		Reduced GO + PEDOT formed
	rGO -P (43 kGy)	43		
	rGO -P (72 kGy)	72		
	rGO -P (100 kGy)	100		
	rGO -P (115 kGy)	115		
	rGO -P (130 kGy)	130		
	rGO -P (160 kGy)	160		
②	**GO-P36 (0 kGy)**	0	[GO] = 1.42 g L^{-1}, [P36] = 10 mM in monomers, [IPA] = 0.2 M	Unirradiated control with PEDOT oligomers
	rGO -P36 (10 kGy)	10		Reduced GO + PEDOT formed
	rGO -P36 (30 kGy)	30		
	rGO -P36 (43 kGy)	43		
	rGO -P36 (60 kGy)	60		
	rGO -P36 (80 kGy)	80		
	rGO -P36 (100 kGy)	100		
	rGO -P36 (120 kGy)	120		
③	**GO-P72 (0 kGy)**	0	[[GO] = 1.42 g L^{-1}, [P72] = 10 mM in monomers, [IPA] = 0.2 M	Unirradiated control with fully polymerized PEDOT
	rGO -P72 (10 kGy)	10		Reduced GO + PEDOT formed
	rGO -P72 (30 kGy)	30		
	rGO -P72 (43 kGy)	43		
	rGO -P72 (60 kGy)	60		
	rGO -P72 (70 kGy)	70		
	rGO -P72 (80 kGy)	80		
	rGO -P72 (100 kGy)	100		

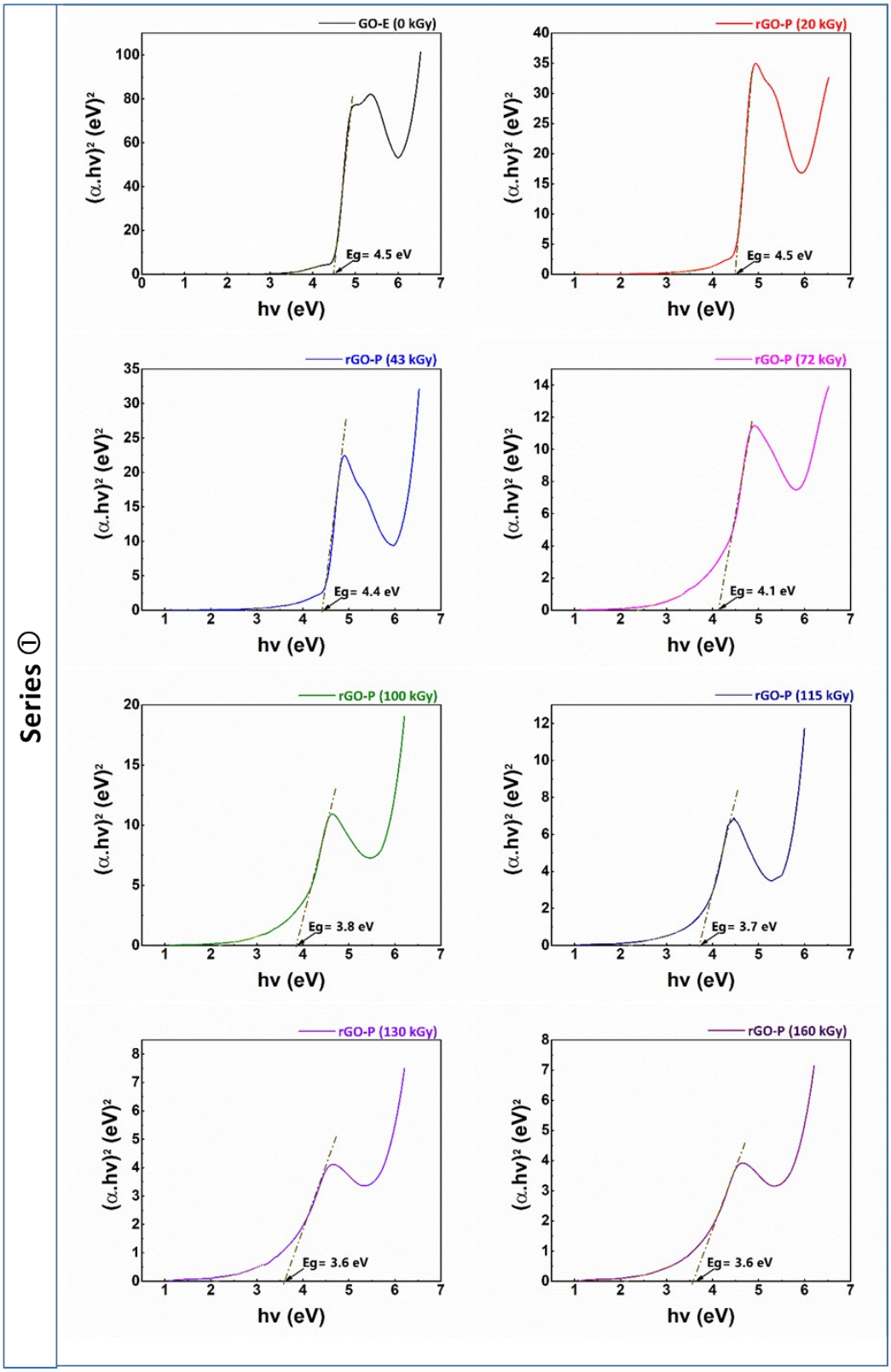

Figure S1. Tauc plots for the samples from Series 1 (GO at 1.42 g L^{-1} and EDOT at 10 mM) as a function of absorbed dose. The optical bandgap values are determined from the intercept of the linear extrapolation of $(\alpha h\nu)^2$ with the photon energy axis (hv) for each sample in Series 1.

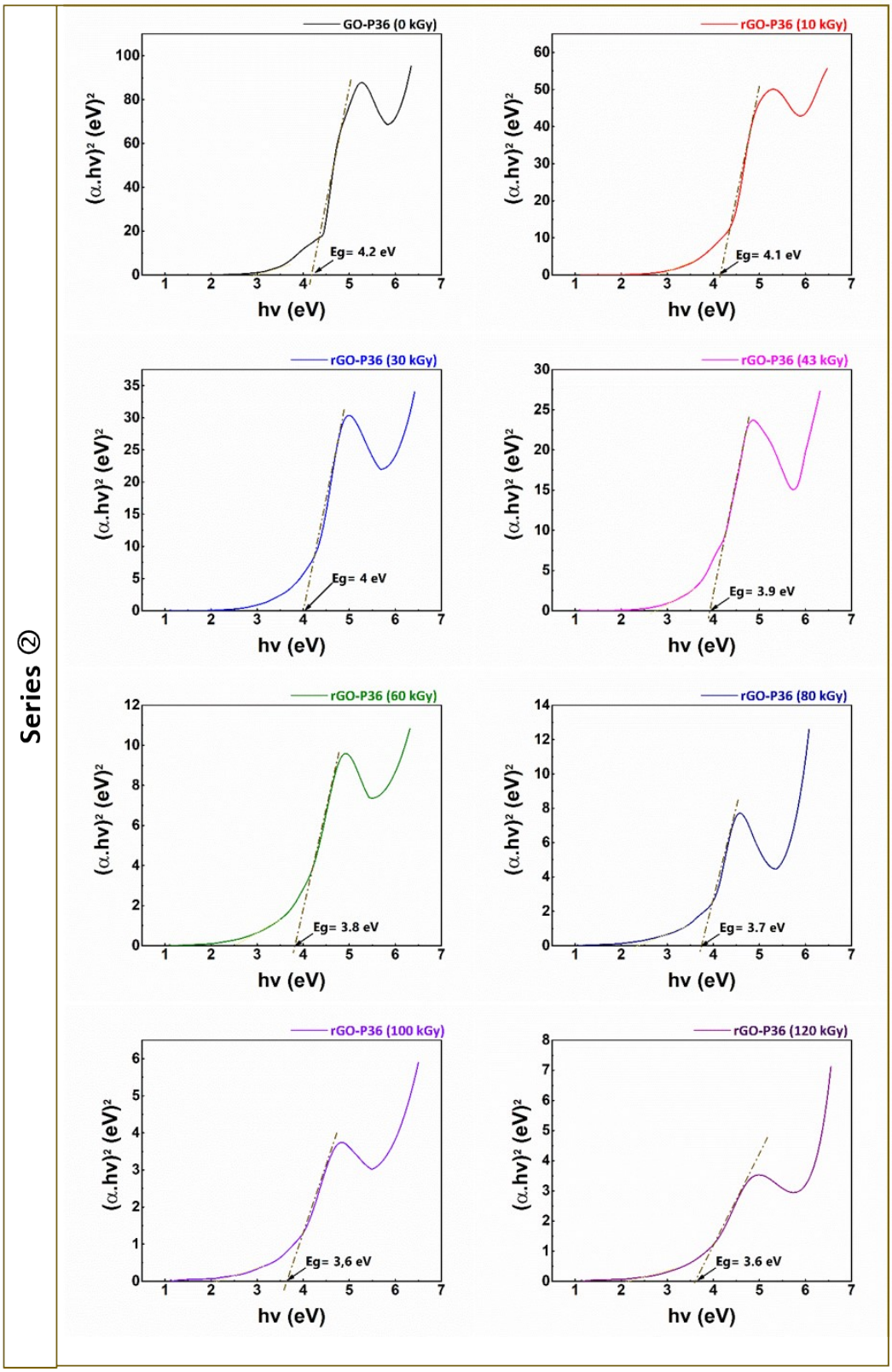

Figure S2. Tauc plots for the samples from Series 2 (GO at 1.42 g L^{-1} and and P36 at 10 mM) as a function of absorbed dose. The optical bandgap values are determined from the intercept of the linear extrapolation of $(\alpha hv)^2$ with the photon energy axis (hv) for each sample in Series 2.

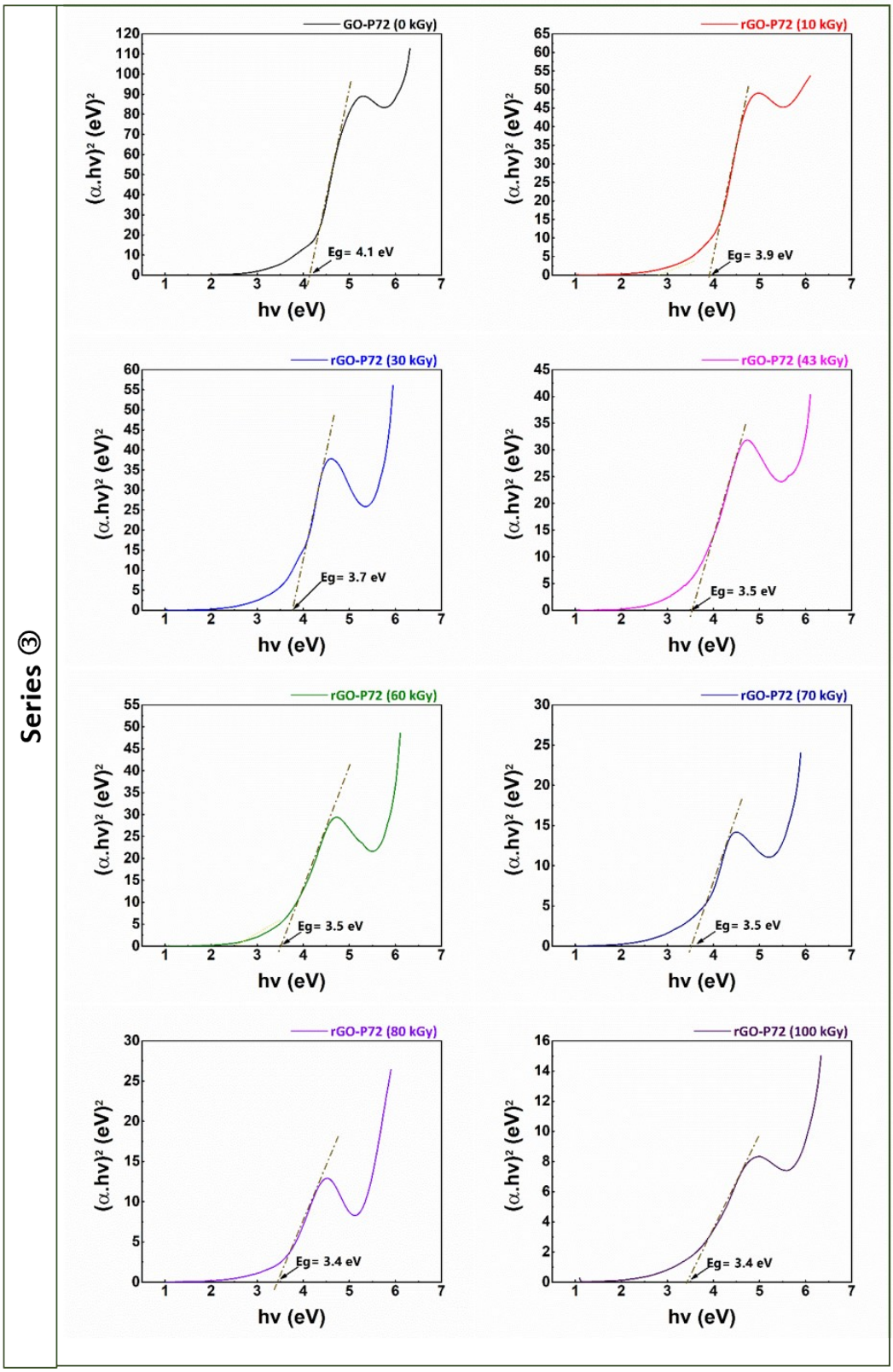

Figure S3. Tauc plots for the samples from Series 2 (GO at 1.42 g L^{-1} and and P72 at 10 mM) as a function of absorbed dose. The optical bandgap values are determined from the intercept of the linear extrapolation of $(\alpha h\nu)^2$ with the photon energy axis (hν) for each sample in Series 3.

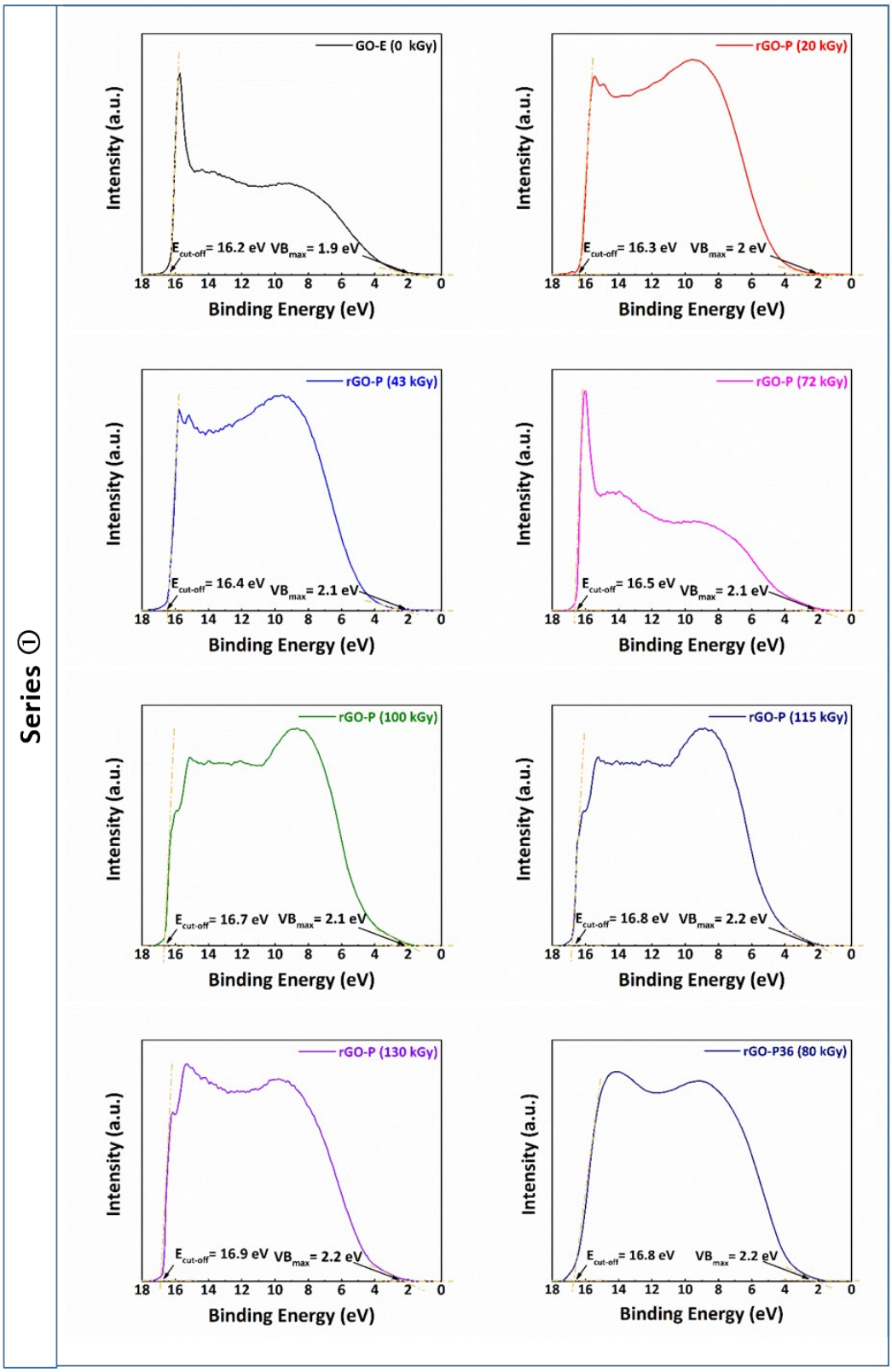

Figure S4. Evolution of the UPS spectra recorded with He I radiation for the samples of Series 1 (GO at 1.42 g L^{-1} and and EDOT at 10 mM) as a function of absorbed dose.

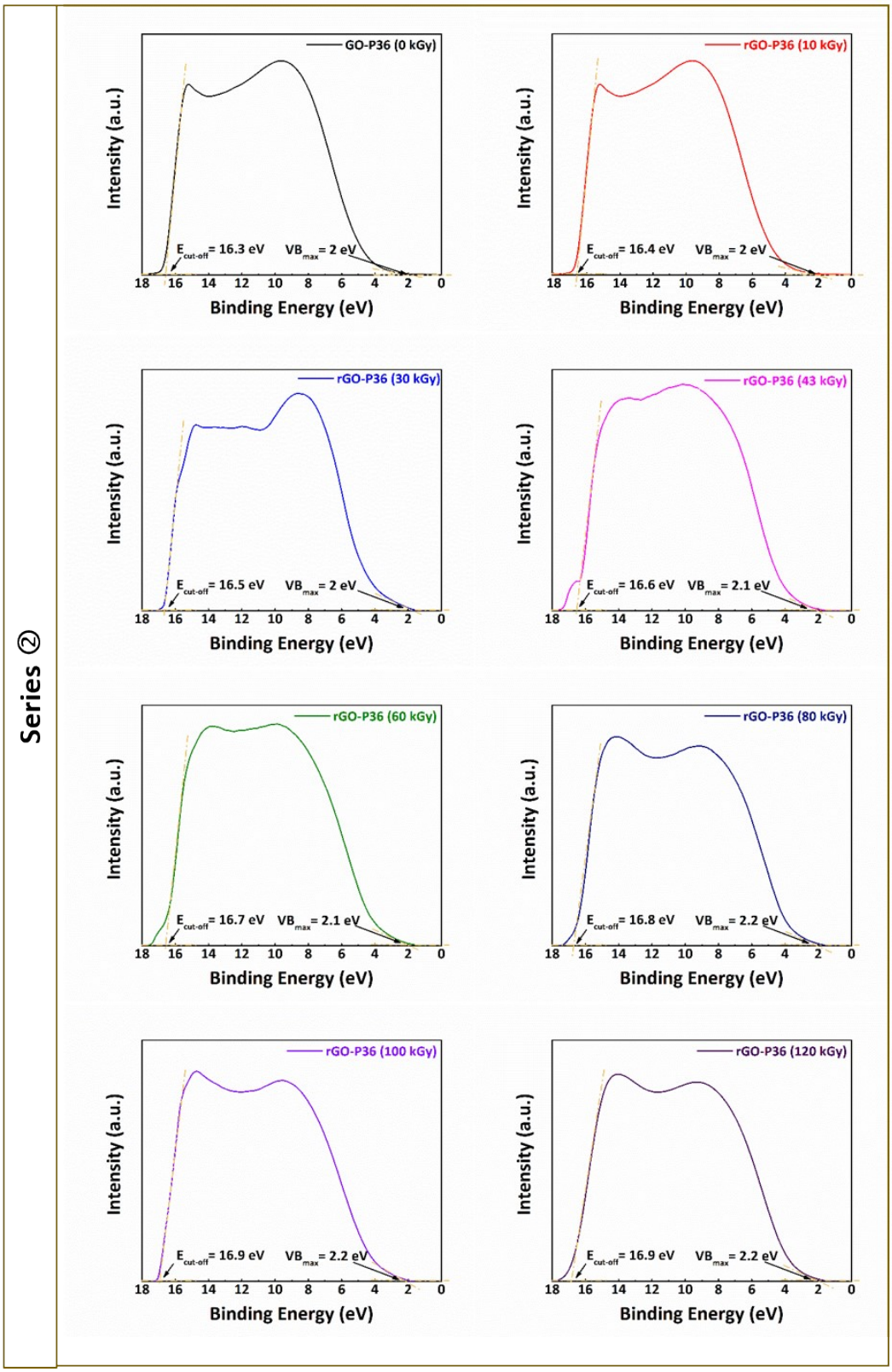

Figure S5. Evolution of the UPS spectra recorded with He I radiation for the samples of Series 2 (GO at 1.42 g L^{-1} and and P36 at 10 mM) as a function of absorbed dose.

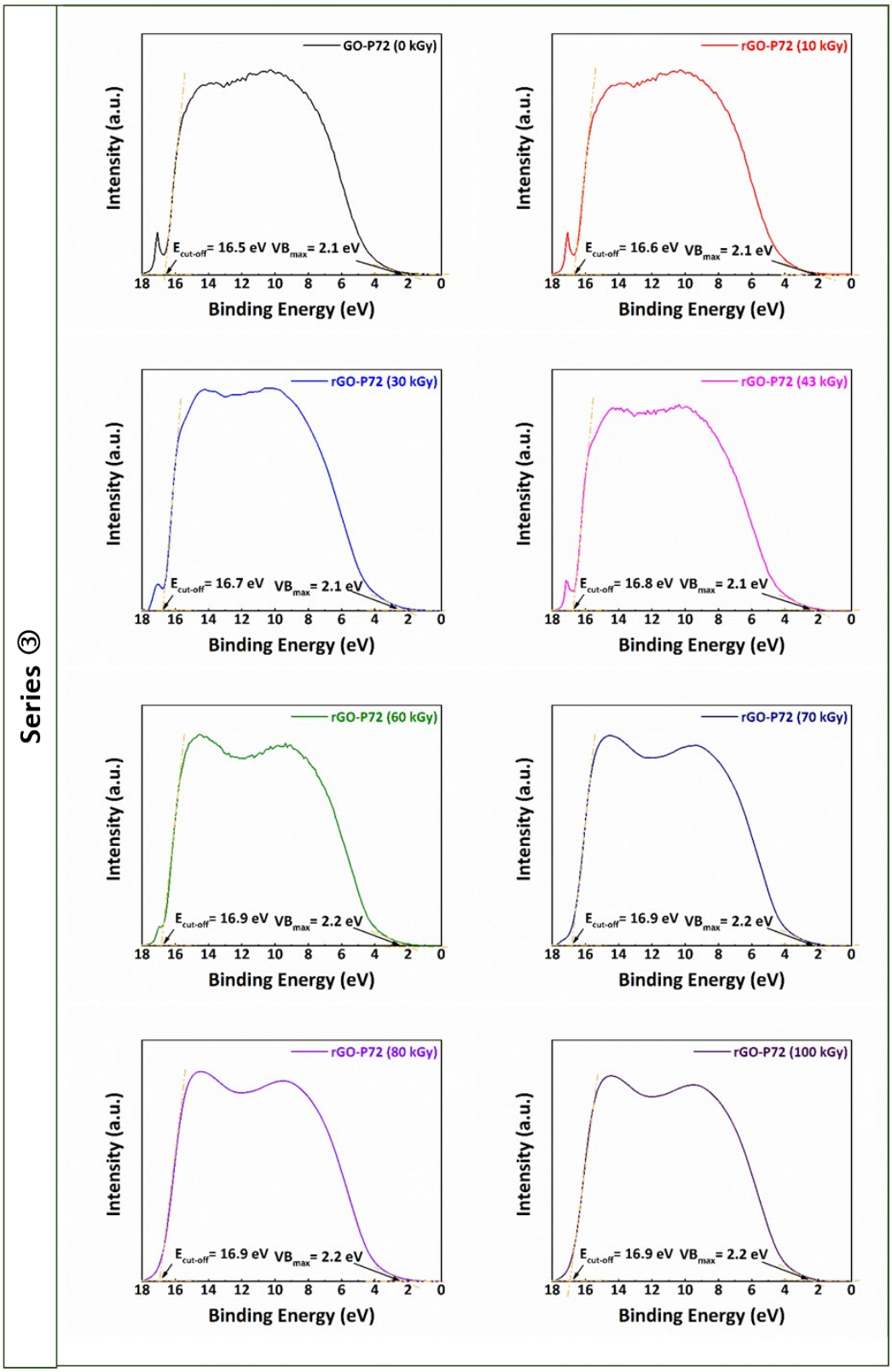

Figure S6. Evolution of the UPS spectra recorded with He I radiation for the samples of Series 3 (GO at 1.42 g L^{-1} and and P72 at 10 mM) as a function of absorbed dose.

Table S2. Values used for the calculation of the energy band structure of all samples as a function of absorbed dose for: (a) Series 1 (GO at 1.42 g L^{-1} and EDOT at 10 mM), (b) Series 2 (GO at 1.42 g L^{-1} and P36 at 10 mM), and (c) Series 3 (GO at 1.42 g L^{-1} and P72 at 10 mM). The uncertainty associated with the determined values is less than 5%.

a-

Series①

Sample	E_g (eV)	VB_{max} (eV)	$E_{cut-off}$ (eV)	WF (eV)	VB (eV)	CB (eV)
GO-E (0 kGy)	4.5	1.9	16.2	5	6.9	2.4
rGO-P (20 kGy)	4.5	2	16.3	4.9	6.9	2.4
rGO-P (43 kGy)	4.4	2.1	16.4	4.8	6.9	2.5
rGO-P (72 kGy)	4.1	2.1	16.5	4.7	6.8	2.7
rGO-P (100 kGy)	3.8	2.1	16.7	4.5	6.6	2.8
rGO-P (115 kGy)	3.7	2.2	16.8	4.4	6.6	2.9
rGO-P (130 kGy)	3.6	2.2	16.9	4.3	6.5	2.9
rGO-P (160 kGy)	3.6	2.2	16.9	4.3	6.5	2.9

Series②

Échantillons	E_g (eV)	VB_{max} (eV)	$E_{cut-off}$ (eV)	WF (eV)	VB (eV)	CB (eV)
GO-P36 (0 kGy)	4.2	2	16.3	4.9	6.9	2.7
rGO-P36 (10 kGy)	4.1	2	16.4	4.8	6.8	2.7
rGO-P36 (30 kGy)	4	2	16.5	4.7	6.7	2.7
rGO-P36 (43 kGy)	3.9	2.1	16.6	4.6	6.7	2.8
rGO-P36 (60 kGy)	3.8	2.1	16.7	4.5	6.6	2.8
rGO-P36 (80 kGy)	3.7	2.2	16.8	4.4	6.6	2.9
rGO-P36 (100 kGy)	3.6	2.2	16.9	4.3	6.5	2.9
rGO-P36 (120 kGy)	3.6	2.2	16.9	4.3	6.5	2.9

Series③						
Échantillons	E_g (eV)	VB_{max} (eV)	$E_{cut-off}$ (eV)	WF (eV)	VB (eV)	CB (eV)
GP-P72 (0 kGy)	4.1	2.1	16.5	4.7	6.8	2.7
rGO-P72 (10 kGy)	3.9	2.1	16.6	4.6	6.7	2.8
rGO-P72 (30 kGy)	3.7	2.1	16.7	4.5	6.6	2.9
rGO-P72 (43 kGy)	3.5	2.1	16.8	4.4	6.5	3
rGO-P72 (60 kGy)	3.5	2.2	16.9	4.3	6.5	3
rGO-P72 (70 kGy)	3.5	2.2	16.9	4.3	6.5	3
rGO-P72 (80 kGy)	3.4	2.2	16.9	4.3	6.5	3.1
rGO-P72 (100 kGy)	3.4	2.2	16.9	4.3	6.5	3.1

b-

c-

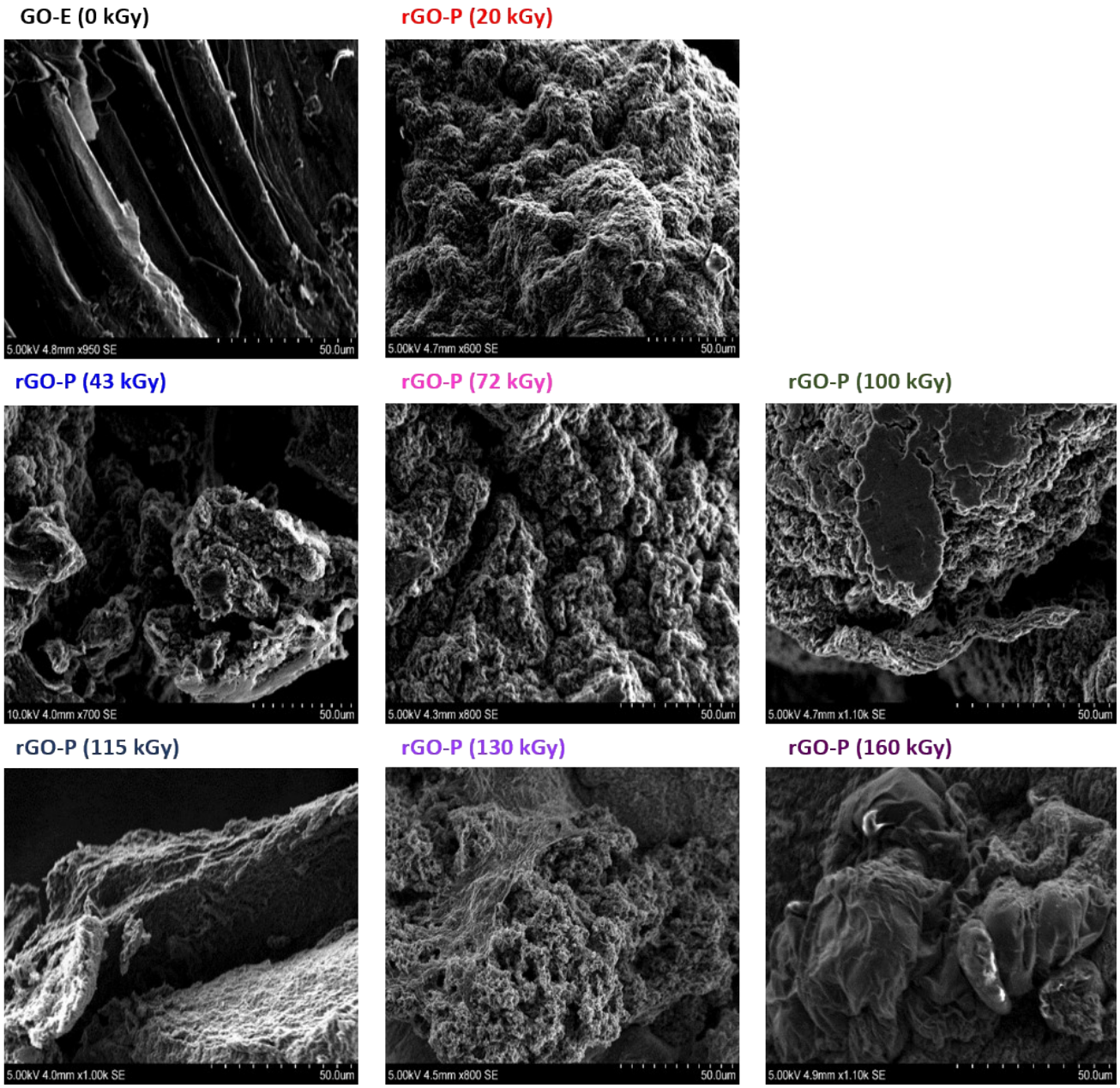

Figure S7. SEM images of the samples from Series 1 (GO at 1.42 g L^{-1} and and EDOT at 10 mM) as a function of absorbed dose. Scale bar: 50 µm.

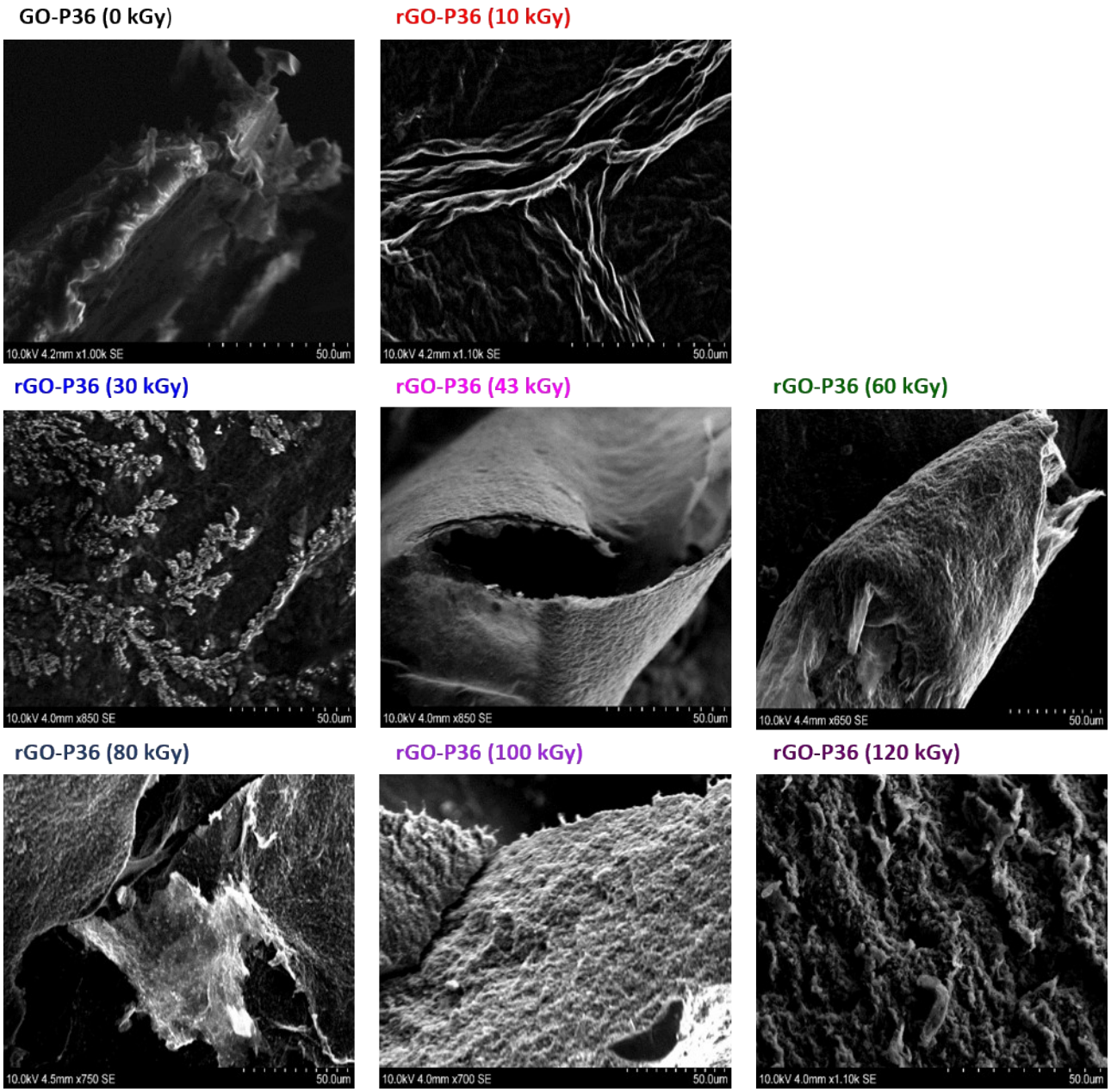

Figure S8. SEM images of the samples from Series 2 (GO at 1.42 g L^{-1} and and P36 at 10 mM) as a function of absorbed dose. Scale bar: 50 µm.

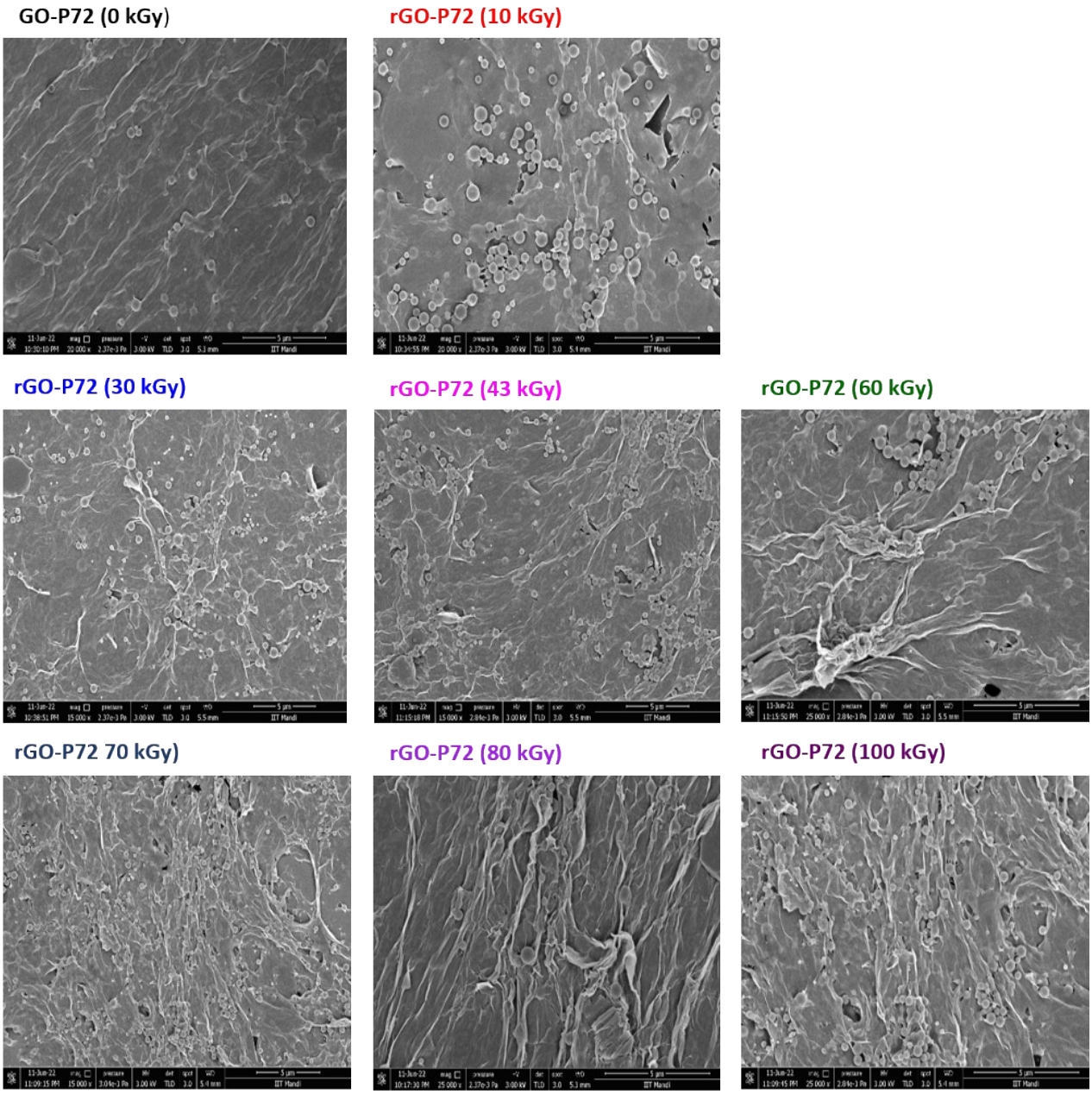

Figure S9. SEM images of the samples from Series 3 (GO at 1.42 g L^{-1} and and P72 at 10 mM) as a function of absorbed dose. Scale bar: 5 µm.

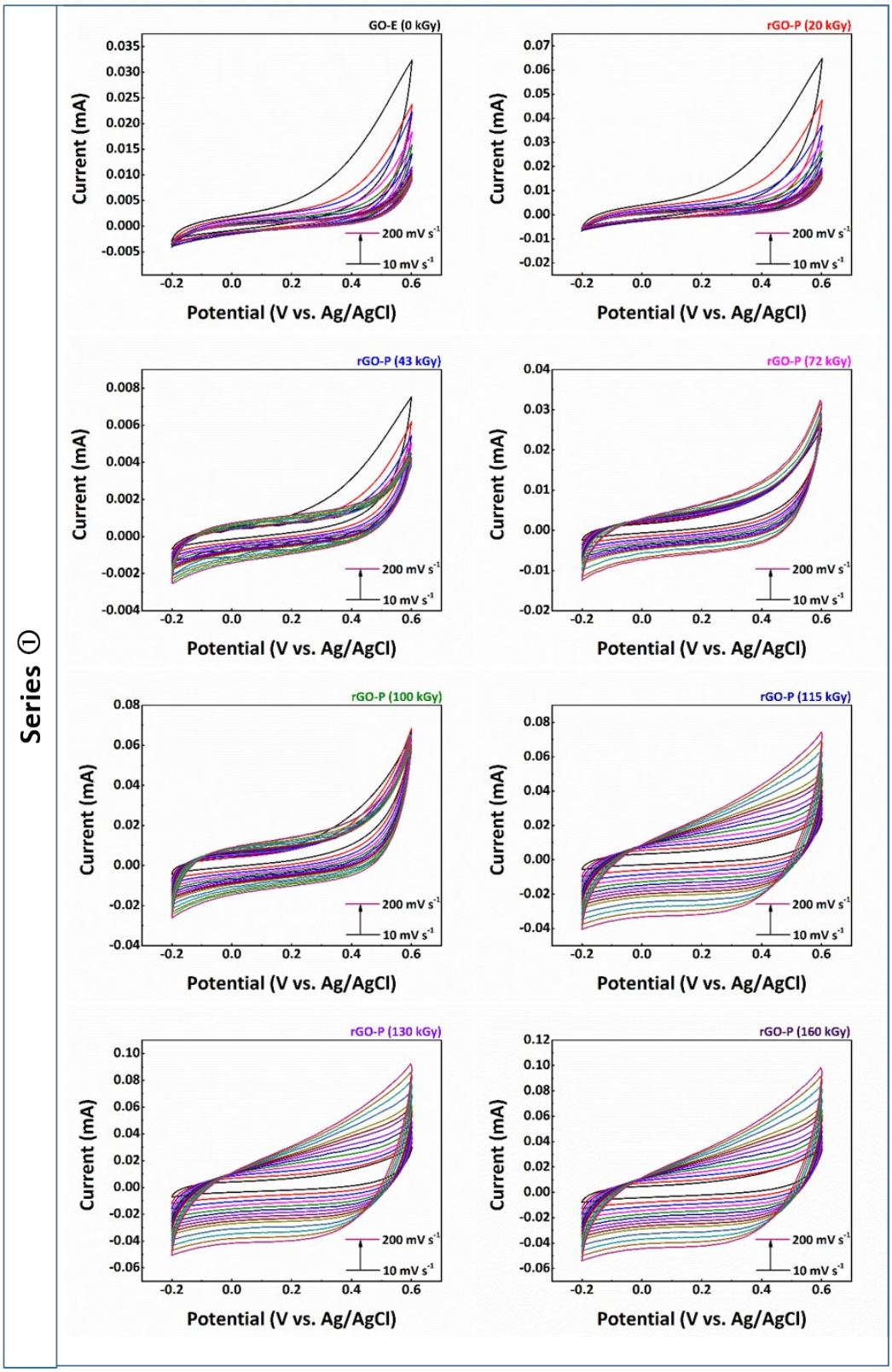

Figure S10. Cyclic voltammograms of the samples from Series 1 (GO at 1.42 g L^{-1} and and EDOT at 10 mM) obtained at various absorbed doses and recorded at different scan rates ranging from 10 to 200 mV s^{-1} in a 0.1 M KOH aqueous solution.

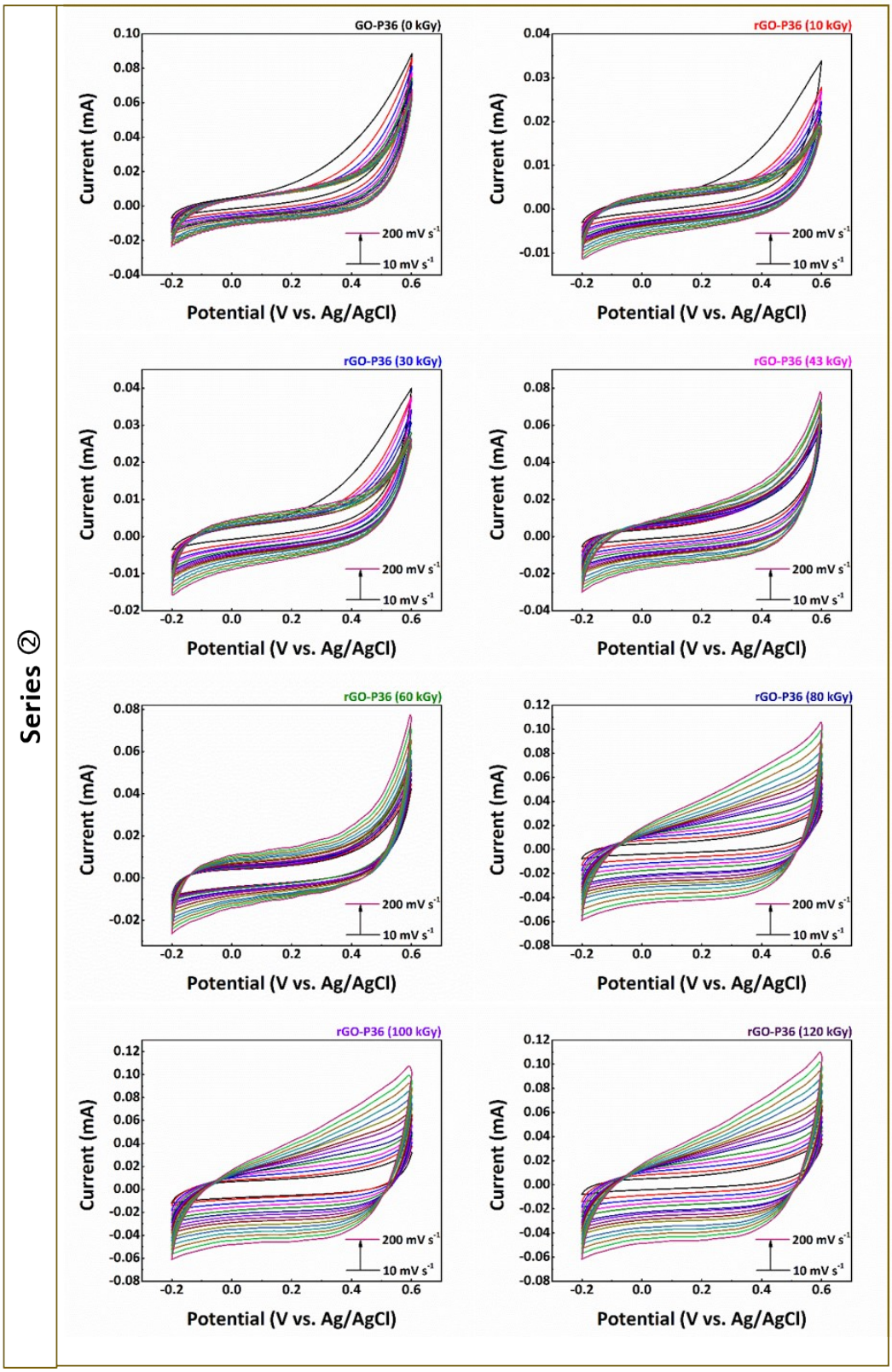

Figure S11. Cyclic voltammograms of the samples from Series 2 (GO at 1.42 g L^{-1} and and P36 at 10 mM) obtained at various absorbed doses and recorded at different scan rates ranging from 10 to 200 mV s^{-1} in a 0.1 M KOH aqueous solution.

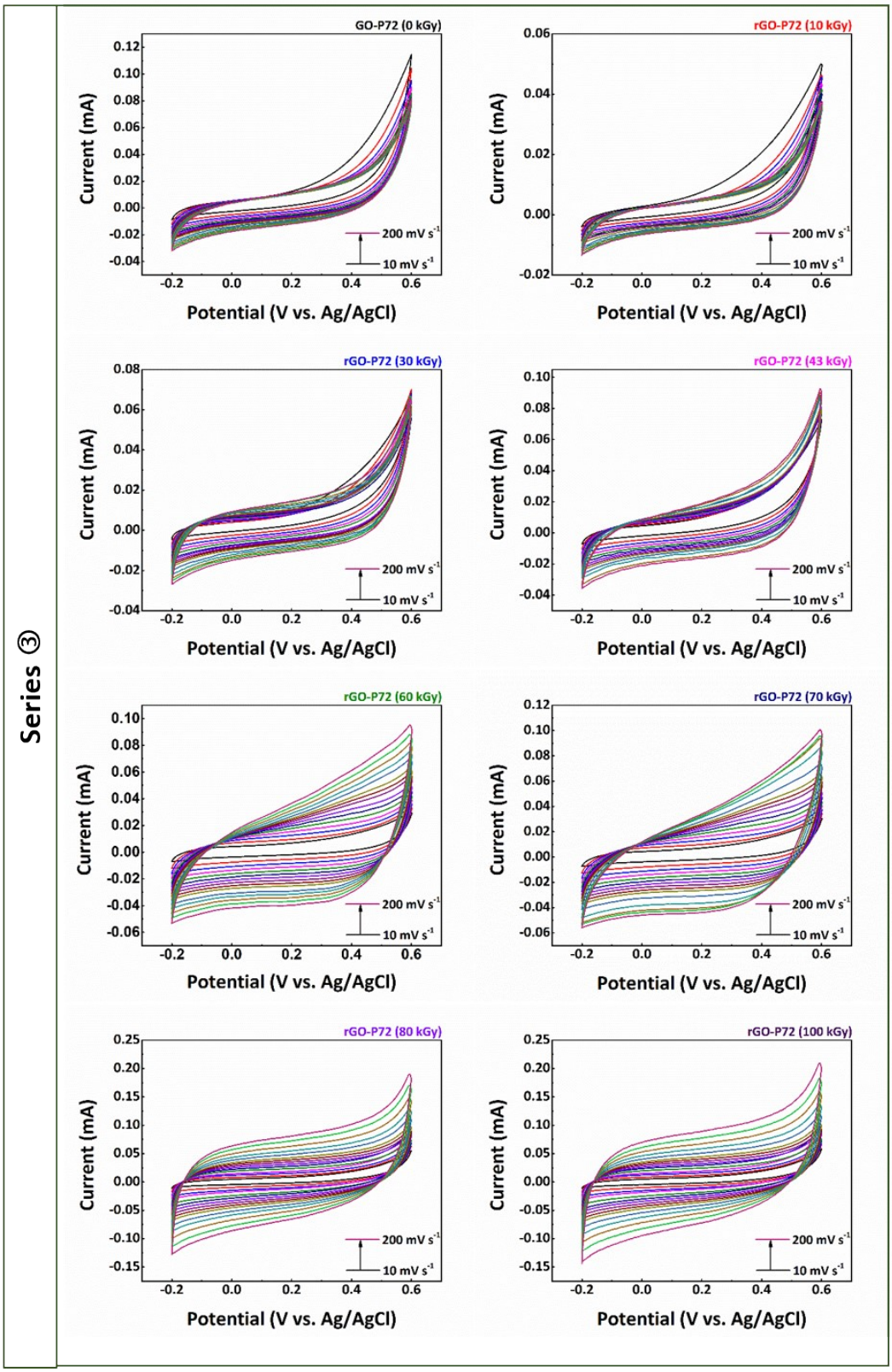

Figure S12. Cyclic voltammograms of the samples from Series 3 (GO at 1.42 g L^{-1} and and P72 at 10 mM) obtained at various absorbed doses and recorded at different scan rates ranging from 10 to 200 mV s^{-1} in a 0.1 M KOH aqueous solution.