Electronic Supplementary Material (ESI) for RSC Advances.

Electronic Supplementary Information

Efficient removal of rhodamine 6G dye from aqueous solution using nickel sulphide incorporated polyacrylamide grafted gum karaya bionanocomposite hydrogel

Neeraj Kumar[a], Hemant Mittal[a,b], Vyom Parashar[a], Suprakas Sinha Ray[a,b], Jane Catherine Ngila*[a]

[a]*Department of Applied Chemistry, University of Johannesburg, Doornfontein 2028, South Africa, E-mail: jcngila@uj.ac.za*
[b]*DST/CSIR National Centre for Nanostructured Materials, Council for Scientific and Industrial Research, Pretoria 0001, South Africa*

Table S1: Optimization of different grafting parameters for the synthesis of BioNC hydrogel.

Sample	**Reaction time / min**	**Temp. / °C**	**Double distilled water / ml**	**Initiator ratio /KPS:ABC**	**MBA / mg**	**AAM / g**	**NiS/ Ni_3S_4 NPs loading (%)**	**P_s**
Gk-cl-PAAm-1	90	50.0	20.0	1:1	50.0	1.0	-	930
Gk-cl-PAAm -2	120	50.0	20.0	1:1	50.0	1.0	-	1208
Gk-cl-PAAm -3	150	50.0	20.0	1:1	50.0	1.0	-	1051
Gk-cl-PAAm -4	180	50.0	20.0	1:1	50.0	1.0	-	812
Gk-cl-PAAm -5	120	40	20.0	1:1	50.0	1.0	-	955
Gk-cl-PAAm -6	120	60	20.0	1:1	50.0	1.0	-	1283
Gk-cl-PAAm -7	120	70	20.0	1:1	50.0	1.0	-	1067
Gk-cl-PAAm -8	120	60	10.0	1:1	50.0	1.0	-	749
Gk-cl-PAAm -9	120	60	15.0	1:1	50.0	1.0	-	996
Gk-cl-PAAm -10	120	60	25.0	1:1	50.0	1.0	-	1145
Gk-cl-PAAm -11	120	60	30.0	1:1	50.0	1.0	-	923
Gk-cl-PAAm -12	120	60	20.0	1:0.25	50.0	1.0	-	845
Gk-cl-PAAm -13	120	60	20.0	1:0.50	50.0	1.0	-	1076
Gk-cl-PAAm -14	120	60	20.0	1:0.75	50.0	1.0	-	1410
Gk-cl-PAAm -15	120	60	20.0	1:1.25	50.0	1.0	-	1071
Gk-cl-PAAm -16	120	60	20.0	1:0.75	40.0	1.0	-	918
Gk-cl-PAAm -17	120	60	20.0	1:0.75	60.0	1.0	-	1112
Gk-cl-PAAm -18	120	60	20.0	1:0.75	70.0	1.0	-	836
Gk-cl-PAAm -19	120	60	20.0	1:0.75	50.0	0.50	-	1047
Gk-cl-PAAm -20	120	60	20.0	1:0.75	50.0	0.75	-	1254
Gk-cl-PAAm -21	120	60	20.0	1:0.75	50.0	1.25	-	1308
Gk-cl-PAAm -22	120	60	20.0	1:0.75	50.0	1.50	-	1157
BioNC hydrogel-1	120	60	20.0	1:0.75	50.0	1.0	1.1	1726
BioNC hydrogel-2	120	60	20.0	1:0.75	50.0	1.0	2.2	2045
BioNC hydrogel-3	120	60	20.0	1:0.75	50.0	1.0	3.3	2398
BioNC hydrogel-4	120	60	20.0	1:0.75	50.0	1.0	4.4	1987

Table S2: Thermodynamic parameters for the adsorption of R6G onto BioNC hydrogel.

Dye	**Temperature /K**	$\Delta G°$ **/kJ.mol^{-1}**	$\Delta H°$ **/kJ.mol^{-1}**	$\Delta S°$ **/ kJ.mol^{-1}.K^{-1}**
	298.15	-3.131		
R6G	308.15	-3.391	46.246	26.012
	318.15	-3.651		

Table S3: The comparison of the maximum adsorption capacity of the BioNC hydrogel, GK-cl-PAAm and NiS NPs.

Adsorbent	**Langmuir parameters**		
	q_m **(mg/g)**	b **x 10^{-3}**	**R^2**
Gk-cl-PAAm	357.57	4.724	0.999
NiS NPs	263.15	6.355	0.998
BioNC hydrogel	1244.71	3.397	0.999

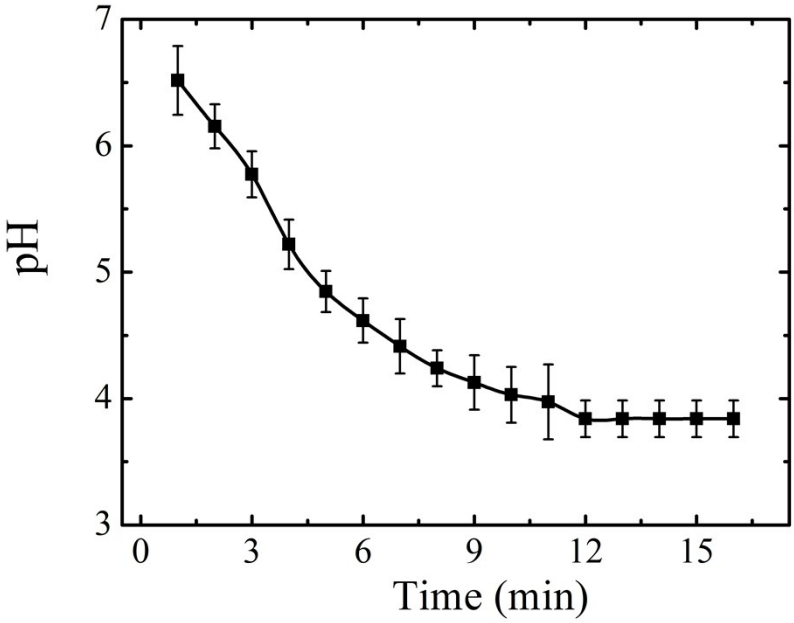

Fig. S1: The variation in the solution pH during the adsorption experiments.

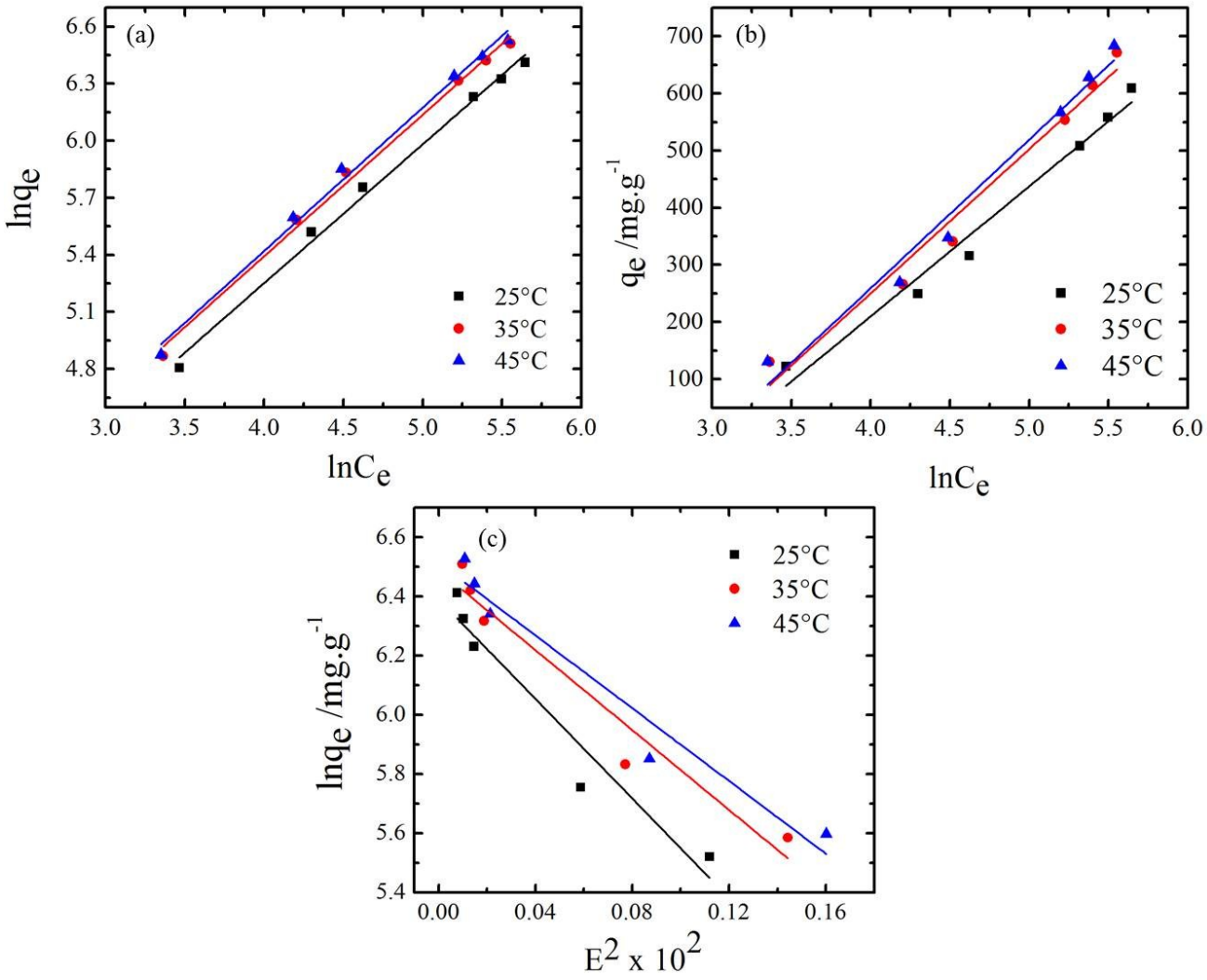

Fig S2(a-c): Plots of the **(a)** Freundlich; (b) Temkin and (c) DKR isotherm models for the adsorption of R6G onto the BioNC hydrogel.

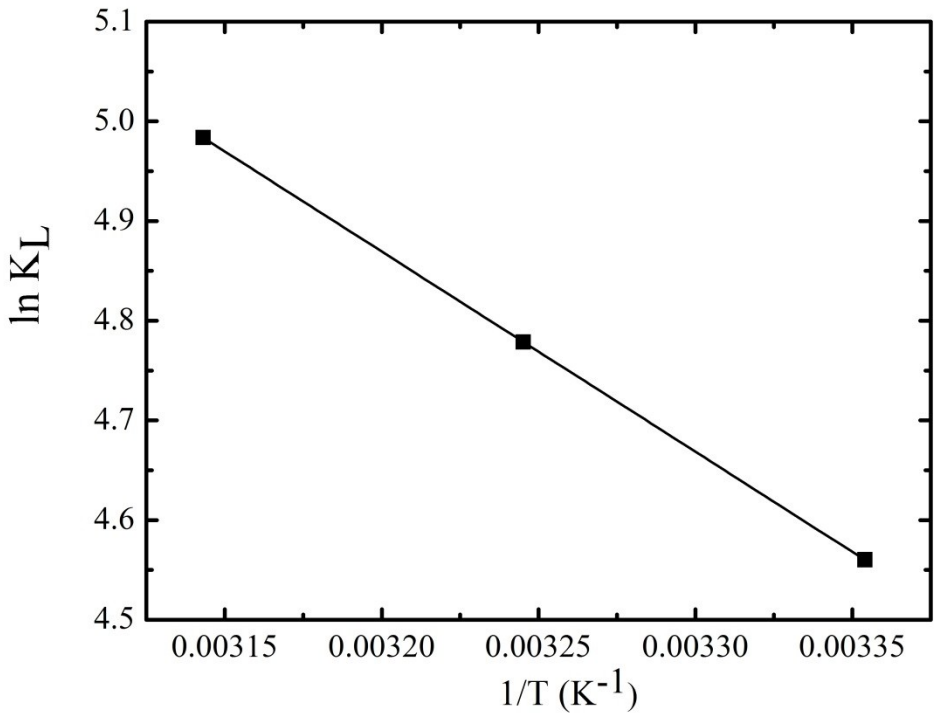

Fig S3: Van't Hoff's plot for the adsorption of R6G onto the BioNC hydrogel.

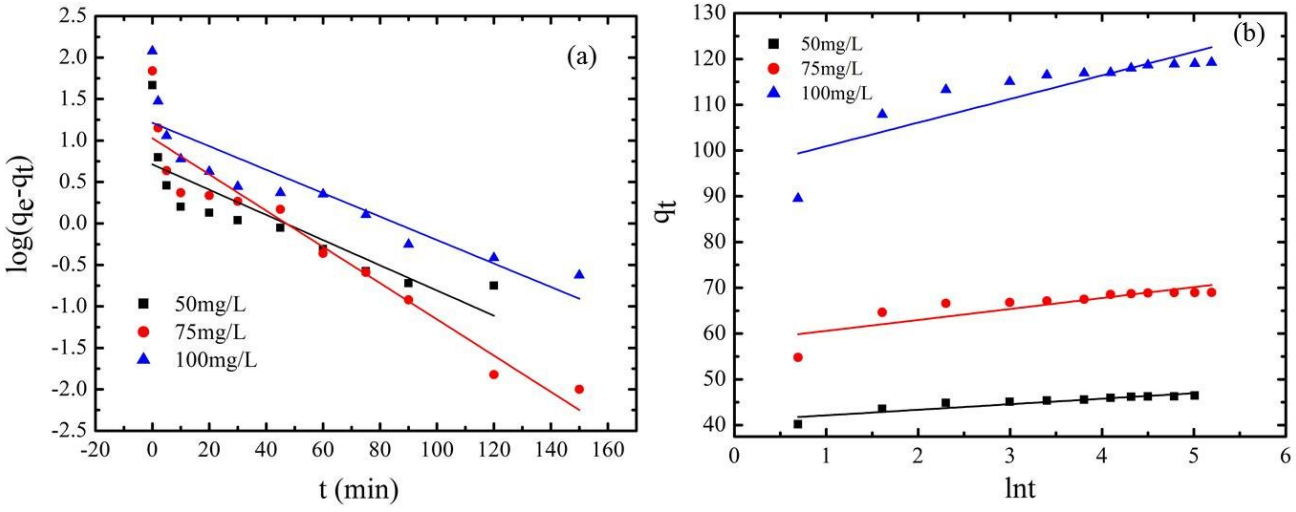

Fig S4 (a-b): Plots of the (a) Pseudo-first-order and (b) Elovich kinetics models for the adsorption of R6G onto the BioNC hydrogel nanocomposite.

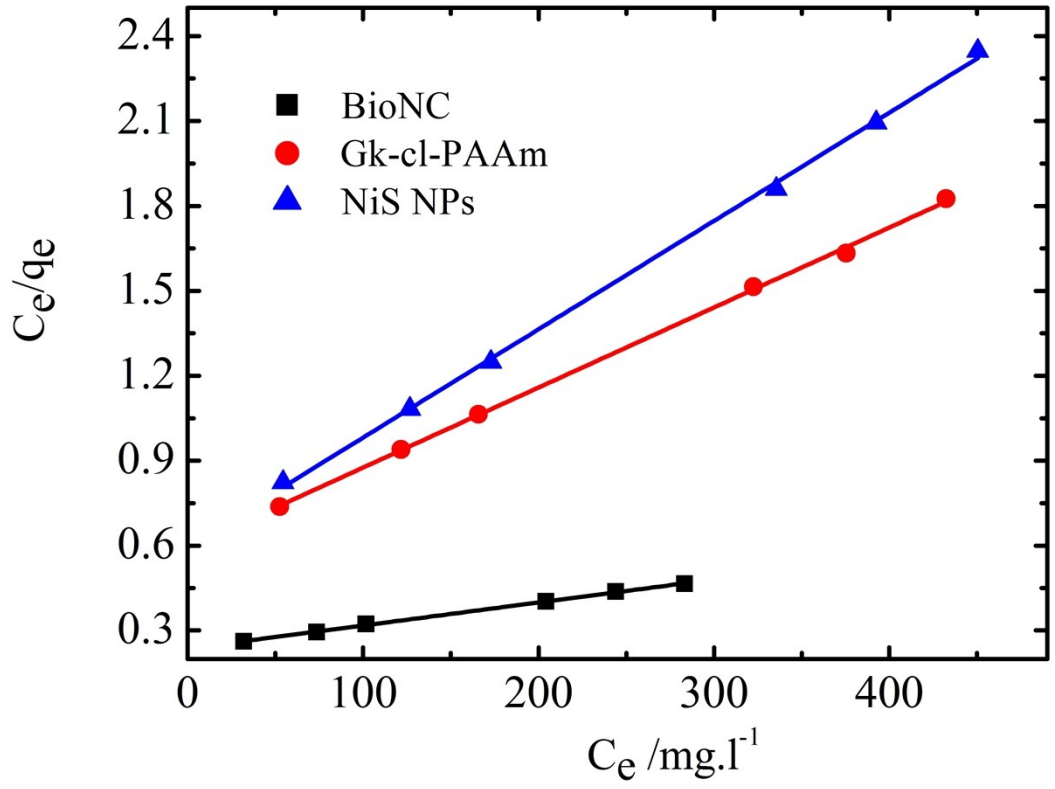

Fig. S5: Comparison of the adsorption capacities of BioNC hydrogel, Gk-cl-PAAm and NiS NPs.

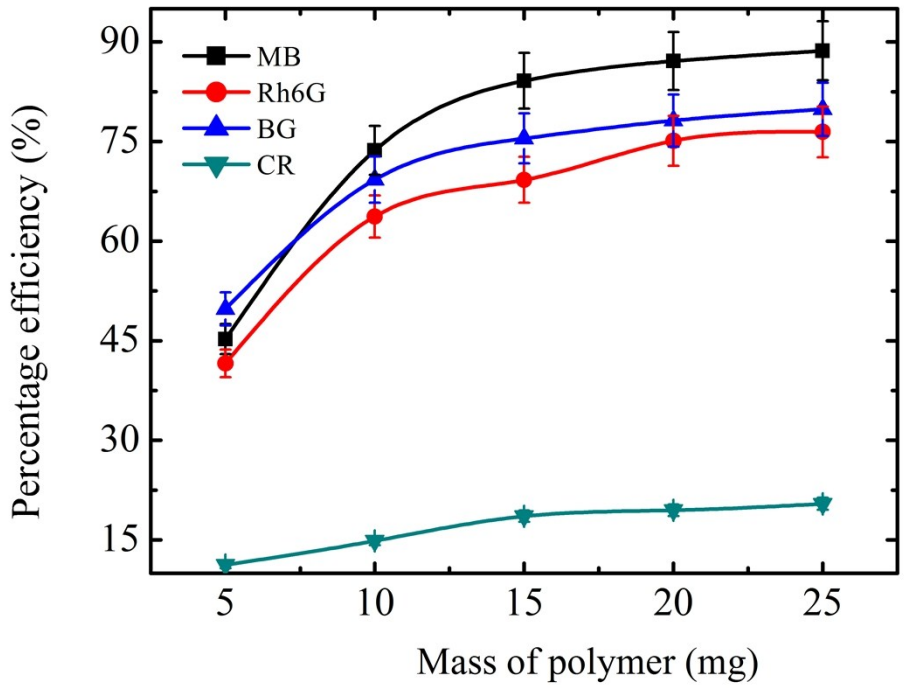

Fig. S6: Effect of polymer does on the adsorption of different dyes.