

**Supporting Information**

# Glycerol-based Dendrimer Nanocomposite Film as A Tunable pH-sensor for Food Packaging

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**Table S1.** Colorimetric analysis of the DD-CP copolymer film latex

pH	RGB Values																				
	Red					Green					Blue										
<b>2.6</b>	254	160	088	232	146	087	214	133	091	229	150	105	224	143	093	216	148	118	233	146	096
<b>3.0</b>	248	155	087	226	143	090	217	140	089	226	152	107	219	150	099	197	147	117	229	155	104
<b>4.0</b>	238	149	082	211	141	093	222	150	101	236	164	112	237	163	110	217	154	113	248	168	108
<b>5.0</b>	213	133	073	194	131	084	248	169	107	228	156	097	214	150	101	229	163	119	237	175	123
<b>6.0</b>	215	143	083	214	153	101	245	176	119	248	182	121	244	182	135	249	187	133	232	169	114
<b>7.0</b>	224	160	092	233	182	123	233	192	130	241	197	133	233	193	128	229	191	142	205	166	114
<b>7.6</b>	233	175	104	234	187	124	226	186	120	242	203	133	241	219	150	221	196	133	210	197	133
<b>9.0</b>	224	163	102	237	196	124	237	197	124	231	196	126	226	205	132	219	219	149	213	203	123
<b>10.0</b>	230	165	097	235	187	121	239	195	128	246	212	137	225	206	138	208	197	132	220	208	129
<b>Time</b>	0 hours		0.5 hours		1.5 hours		5 hours		9 hours		24 hours		48 hours								

**Table S2.** General content for miniemulsion copolymerization system of glycerol-based dendrimer copolymer encapsulated dye nanoparticles

Mixture	Component	Load (g)	Percentage in Mixture (%)	Percentage in Monomer (%)
<b>Oil Phase</b>	Methyl Methacrylate/ Butyl Acrylate	8.4/3.0	7.3/2.61	70/25
	Styrene	9.6-11.4	9.94-8.37	95-80
	Glycerol-based Dendrimer	0.6-2.4	0.52-2.9	5-20
	Hexadecane	1.742	1.51	13.95
	Dye	0.024	0.003	0.25
	AIBN	0.24	0.21	2
<b>Water Phase</b>	DI Water	100	86.9	83.3
	TX-405	1	0.86	8.33

**Note:** Styrene and MMA/BA are not added in the system at the same time.

**Table S3.** Particle size and PDI of four copolymer latex under acidic and neutral pH.

Sample	Particle Size (z- avg.)	Particle Size (z- avg.)	PDI pH 3.0	PDI pH 7.2
	<u>Diameter,</u> <u>pH 3.0</u>	<u>Diameter,</u> <u>pH 7.2</u>		
CP	156.2±1.1	153.7±2.2	0.118±0.001	0.088±0.016
Dye – CP	165.5±2.5	159.1±3.2	0.127±0.008	0.062±0.002
Den – CP	193.6±0.3	182.7±1.1	0.118±0.22	0.073±0.007
DD-CP	161.3±7.1	160.8±1.6	0.182±0.037	0.184±0.003

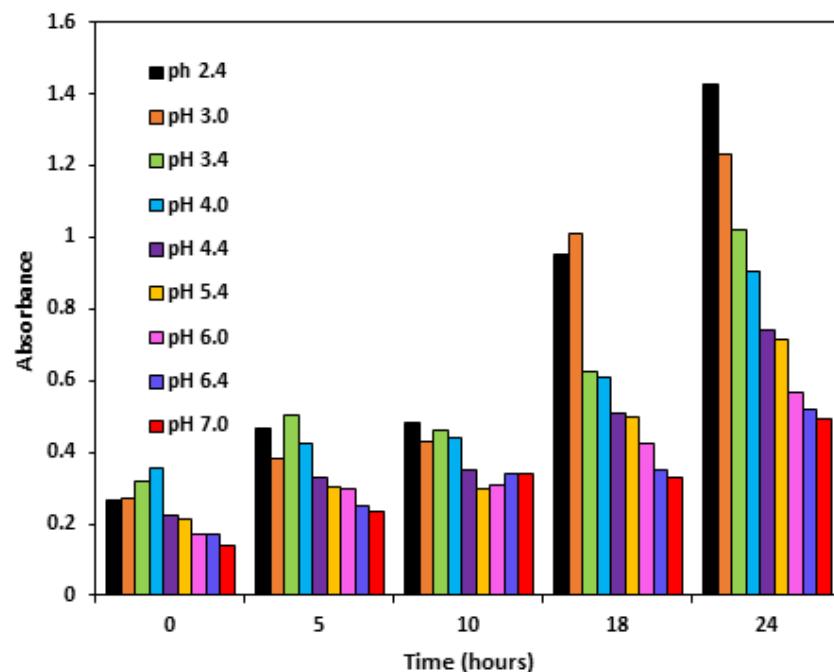
**Table S4.** Molecular weight and dispersity of copolymer films.

Sample ID	Sample Description	Molecular Weight (g/mol)	Dispersity
CP	Empty copolymer	405,418 $\pm$ 83013	2.64 $\pm$ 0.03
Dye-CP	Dye + Copolymer	382,838 $\pm$ 90928	3.02 $\pm$ 0.78
Den-CP	Dendrimer + Copolymer	17,798 $\pm$ 6263	2.82 $\pm$ 1.59
DD-CP	Dye + Dendrimer + Copolymer	246,248 $\pm$ 47893	2.41 $\pm$ 0.17

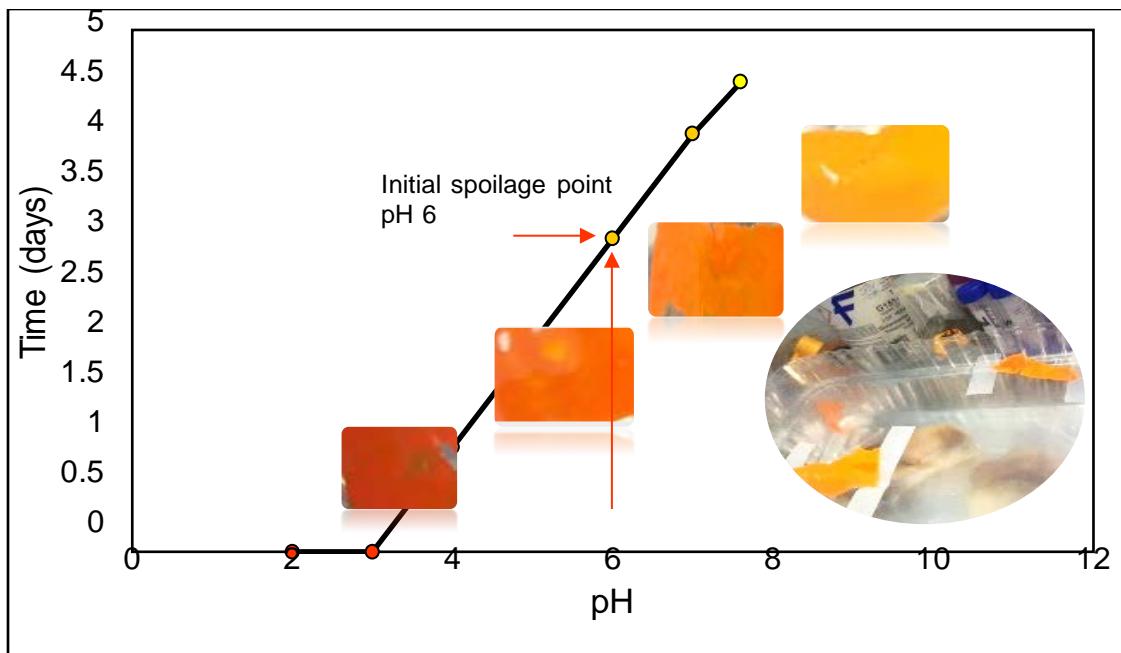
**Table S5.** Thermal properties of copolymer films (CP, Dye-CP, Den-CP, DD-CP).

Sample	T <sub>50%</sub> (°C)	T <sub>95%</sub> (°C)	Glass Transition Temperature (T <sub>g</sub> °C)
CP	340	200	73.56
Dye-CP	337	156	71.23
Den-CP	345	126	70.10
DD-CP	380	340	79.95

**Method S1.** Purification of acryloyl chloride. In a dark amber glass bottle, 2 g charcoal was weighed and sealed. The amber glass bottle was then placed in an ice bath to keep the system cool from producing heat exothermically. After which, 40 mL acryloyl chloride was deposited into the amber glass bottle. The reaction mixture was stored and refrigerated (4 °C) for complete purification purposes for 24 hrs. before use. Purified acryloyl chloride was collected by a syringe from the top liquid layer of the amber glass bottle and stored in a flammable refrigerator at 4 °C.



**Figure S1.** The UV absorbance representing the dye release from the copolymer core with the progression of time (0-24 hours) at varying pH (2.4-7.0).



**Figure S2.** Film color and pH change during the non-contact fish spoilage process at room temperature