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# Supporting Information

# Direct Synthesis of Carbon Quantum Dots in Aqueous Polymer Solution: One-Pot Reaction and Preparation of Transparent UV-Blocking Films

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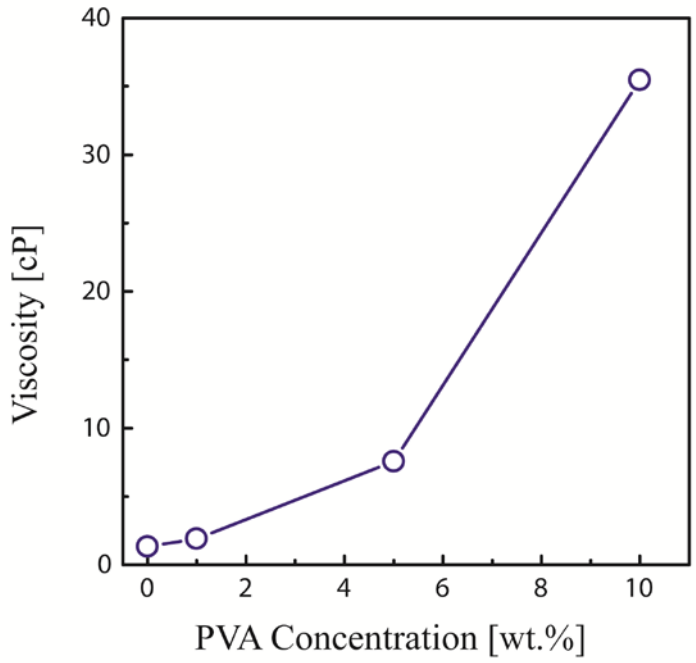


**Fig. S1:** Viscosity measurements of CQD precursor solutions containing 0, 1, 5 or 10 wt.% of PVA. The viscosity was measured at RT.

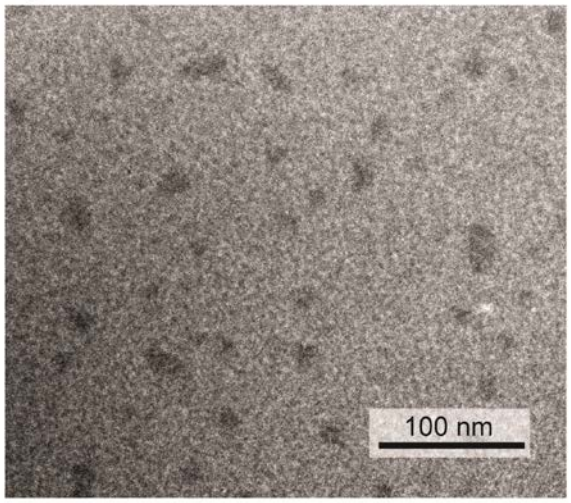


**Fig. S2:** TEM images of particles synthesized from 10 wt.% PVA, 10 wt.% CA, 2 wt.% b-PEI.

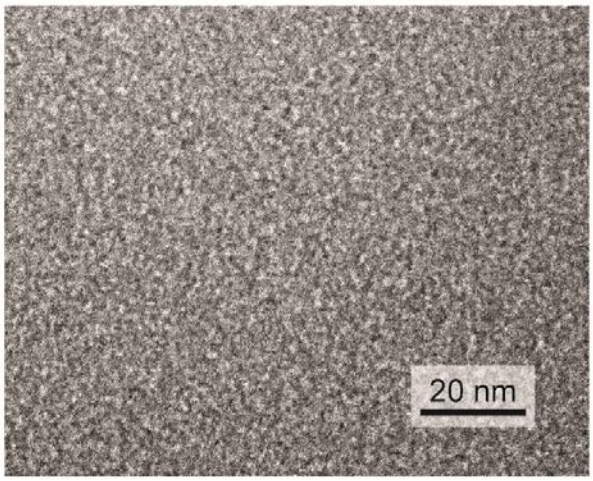


**Fig. S3:** Control TEM image of empty grid.

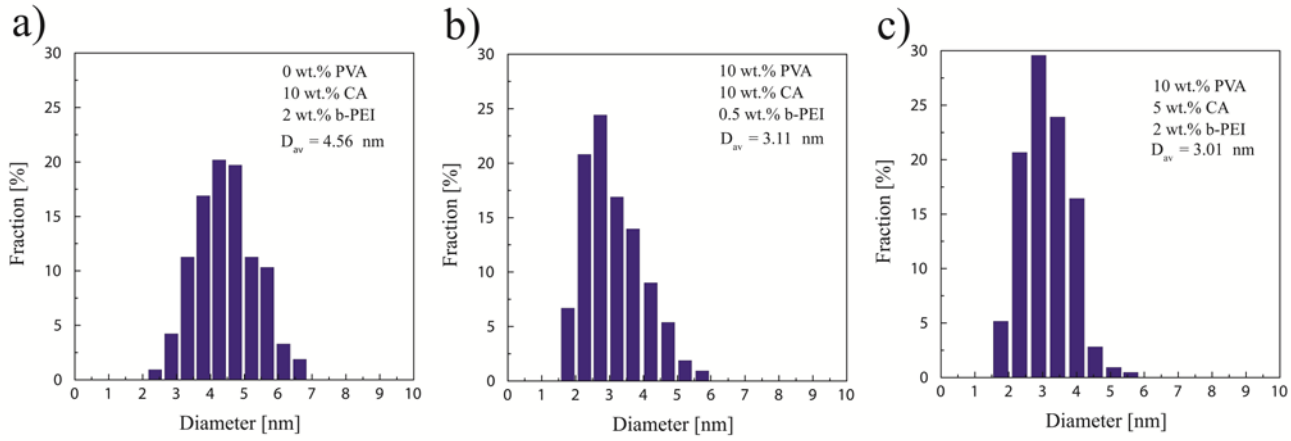


**Fig. S4:** Particle size distribution from TEM images. 213 CQDs were measured per sample a), b) and c).

| **Table S1** pH as function of the citric acid (CA) concentration. | | | |
|---|---|---|---|
| CA concentration | pH | | |
| | Precursor | After synthesis for 15 min, 135 °C | Synthesized solution diluted 1:200 |
| 10 wt.% | 3.0 | 2.8 | 3.5 |
| 5 wt.% | 3.9 | 3.9 | 4.0 |
| 1 wt.% | 8.4 | 8.8 | 9.1 |
| All aqueous solutions contained: 10 wt.% PVA and 2 wt.% b-PEI. | | | |

| **Table S2** pH as function of the b-PEI concentration. | | | |
|---|---|---|---|
| b-PEI concentration | pH | | |
| | Precursor | After synthesis for 15 min 135 °C | Synthesized solution diluted 1:200 |
| 5 wt.% | 4.3 | 4.3 | 4.7 |
| 2 wt.% | 3.0 | 2.8 | 3.5 |
| 0.5 wt.% | 2.2 | 2.0 | 3.1 |
| All aqueous precursor solutions contained: 10 wt.% PVA, 10 wt.% CA. | | | |

| **Table S3** Comparison of solution and film absorbance | | | |
|---|---|---|---|
| **CA (wt.%)** | **pH diluted solution** | **Absorbance 171.5 µm solution*** | **Absorbance dry film** |
| 1 | 9.1 | 0.11 | 0.21 (+91%) |
| 5 | 4.0 | 2.49 | 2.09 (-16%) |
| 10 | 3.5 | 2.83 | 3.19 (+13%) |
| *calculated from measured values (1:200 diluted solution, 1 cm cuvette) according to Lambert-Beer. | | | |

| **Table S4** Film thicknesses. | |
|---|---|
| **Sample** | **Thickness** |
| 1 wt.% CA | 31 µm* |
| 5 wt.% CA | 34 µm* |
| 10 wt.% CA | 49 µm* |
| *mean value of three measurements per sample. Films were all casted with a 171.5 µm pitch spiral bar. | |

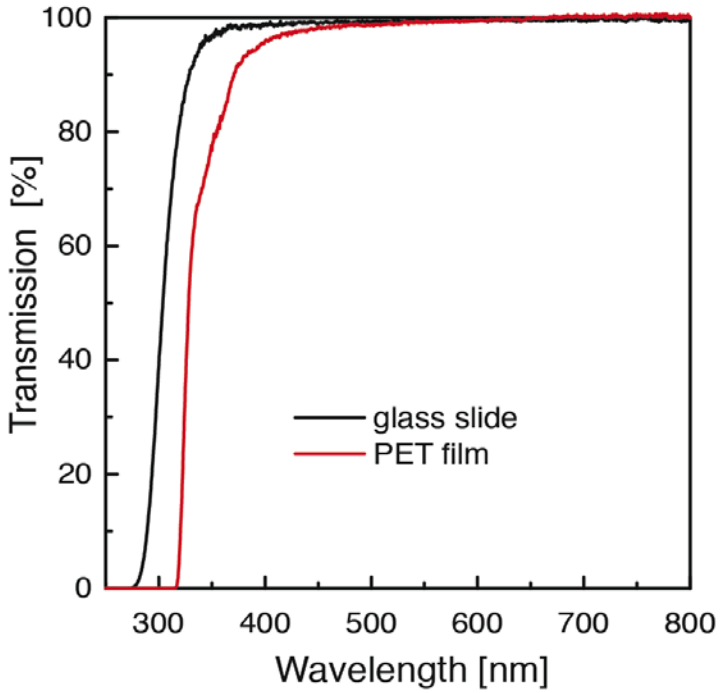


**Fig. S5:** UV-Vis transmission values of a PET film cut out from a commercially available PET bottle and an uncoated glass slide.

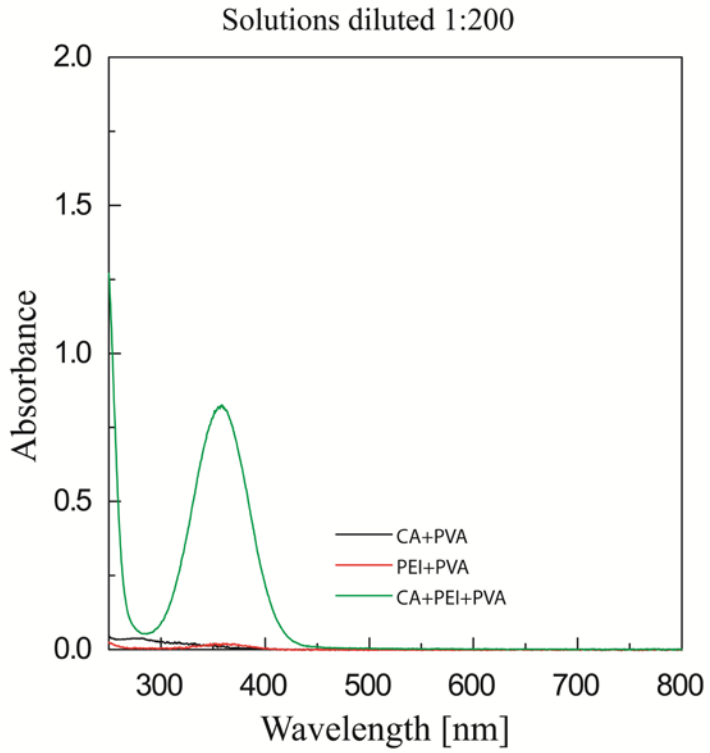


**Fig. S6:** Aqueous solution containing CA (10 wt.%) + PVA (10 wt.%) was synthesized for 15 min at 165 °C, the aqueous solution containing b-PEI (2 wt.%) + PVA (10 wt.%) was synthesized for 15 min at 135 °C and the one containing CA (10 wt.%) + b-PEI (2 wt.%) + PVA (10 wt.%) was synthesized for 15 min at 135 °C. All the solutions were diluted 1:200 before UV-Vis absorbance was measured.

**Table S5** Comparative overview of recently reported, commercially available and our UV protection film.

| **Filler** | **Polymer matrix** | **Transmission (%) at:** | | | | | **Vis-transmission/ UV-A block factor** | **Reference** |
|---|---|---|---|---|---|---|---|---|
| | | 350 nm | 400 nm | 500 nm | 600 nm | 700 nm | | |
| Cellulose nanocrystals (0.5 wt.%) | PVA | <75 | >80 | >85 | >85 | >85 | 1.1 | [14] |
| Graphene Oxide (0.8 wt.%) | PVA | <20 | >30 | >50 | >70 | >75 | 2.8 | [9] |
| CQD's | PVA | <60 | >70 | >75 | >75 | >90 | 1.3 | [20] |
| * | PP | <30 | >90 | >95 | >95 | >95 | 3.1 | Easy Coat BC-753** |
| CQD's | PVA | < 5 | >20 | >75 | >85 | >95 | 13.8 | This work |

*information not provided, **commercially available UV-A protection film, Maruwakako Co., Ltd.

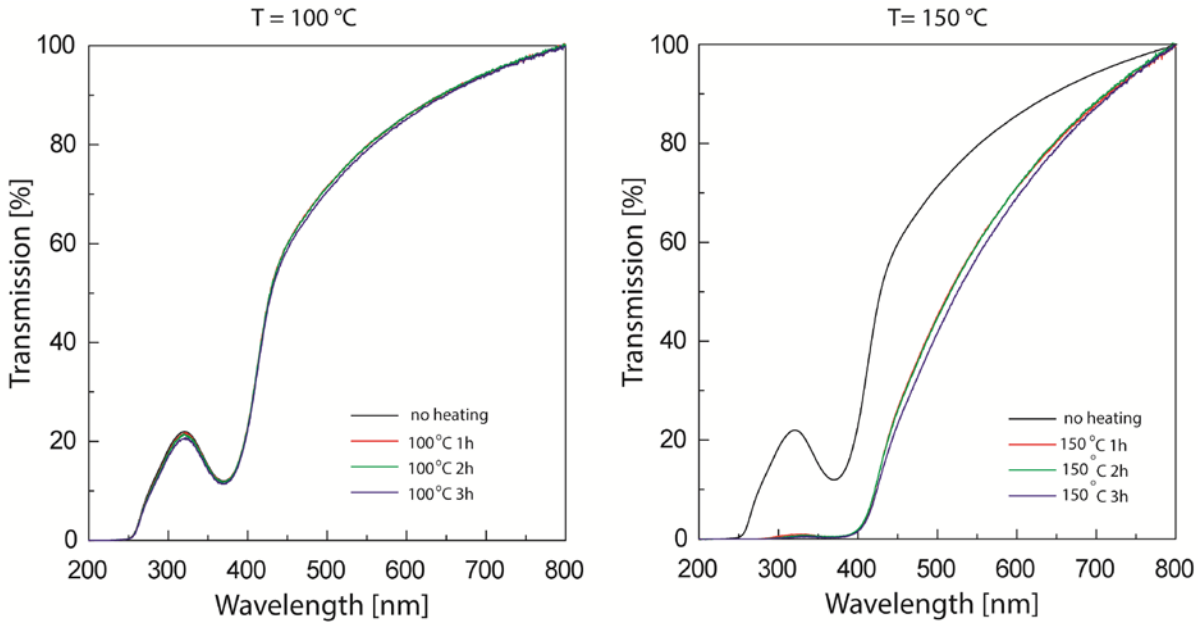


**Fig. S7:** Temperature stability testing of CQD-PVA films at 100 and 150 °C after 1, 2 and 3 hours of heat exposure. The films were tested on their UV-Vis transmission before and after exposure to elevated temperatures.