Preparation of nitrogen-doped carbon quantum dots and it's application as fluorescent probe for Cr(VI) detection

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Optimization of preparation conditions for N-CQDs

The results showed that the fluorescence intensity of N-CQDs was affected by reaction time, reaction temperature and gelatin dosage. Therefore, the optimum preparation conditions of N-CQDs were determined by single factor optimization experiments and orthogonal experiments.

Single factor experiment

Single factor optimization experiments were carried out as follows: Firstly, according to the preparation method of N-CQDs, the time is set to 2 h, 4 h, 6 h, 8 h and 10 h to optimize the time, separately. Secondly, on the basis of the preparation method of N-CQDs, the temperature heated at 140 ℃, 160 ℃, 180 ℃, 200 ℃, 220 ℃ to select the optimum temperature for preparing N-CQDs, respectively. Thirdly, based on the preparation method of N-CQDs, the optimum gelatin dosage for N-CQDs was obtained by changing the amount of gelatin to 3 g, 4 g, 5 g, 6 g and 7 g, respectively. The experimental results are shown in Fig. S1, Fig. S2 and Fig. S3, respectively.

Orthogonal experiment

The time, temperature and gelatin dosage as the influencing factors, a three-factor and three-level experiment was designed according to the single factor optimization result, as shown in Table S1. The orthogonal table L_9 (3^3) was selected for experimentation without considering the interaction of various factors. The orthogonal experimental table is shown in Table S2. Orthogonal experimental results are shown in Table S3.
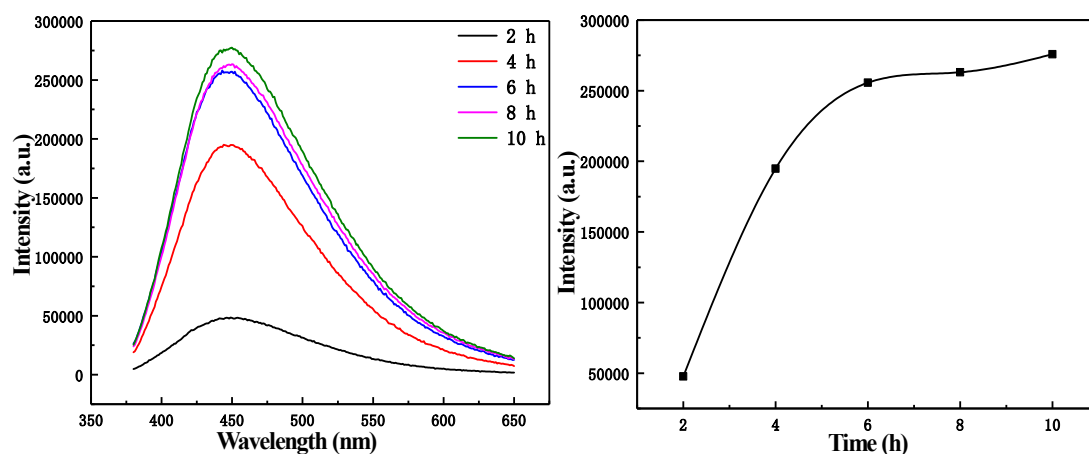

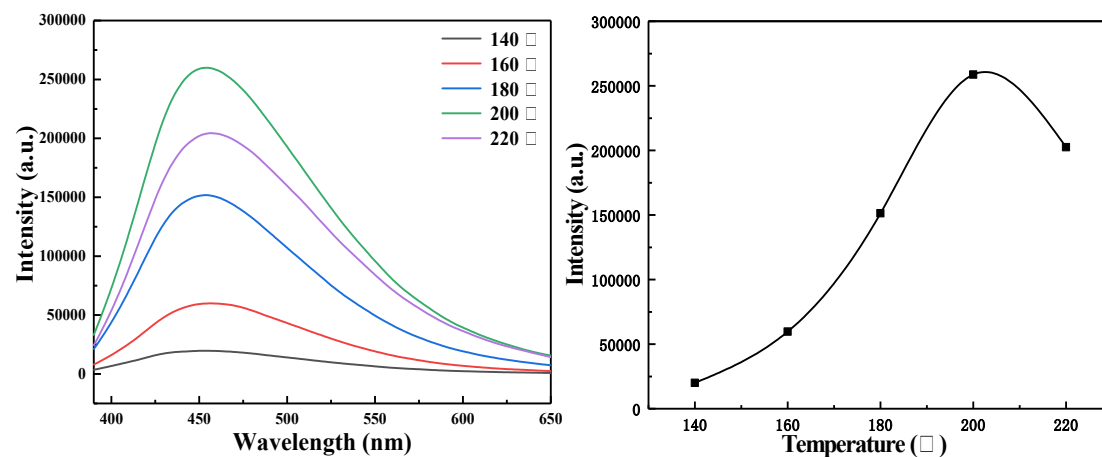**Fig. S1** Fluorescence spectra of N-CQDs at different time

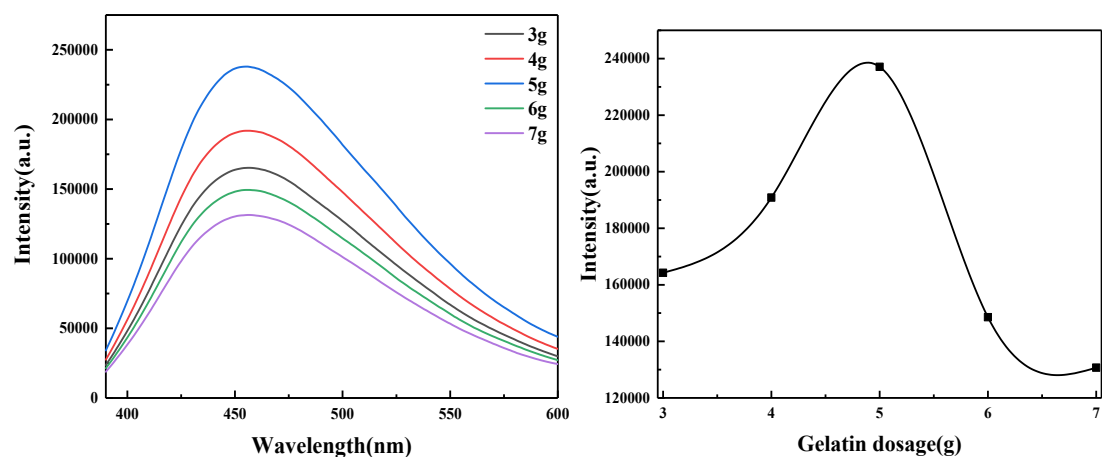**Fig. S2** Fluorescence spectra of N-CQDs at different temperatures

Fig. S3 Fluorescence spectra of N-CQDs at different gelatin dosage

Tab. S1 The factors and levels of orthogonal experiment

Level	(A) Time/ h	(B) Temperature/ ℃	(C) gelatin dosage/ g
1	4	180	4
2	6	200	5
3	8	220	6

Tab. S2 The orthogonal experiment scheme

Experiment number	A	B	C	Experimental program
1	1	1	1	$A_1B_1B_1$
2	1	2	2	$A_1B_2C_2$
3	1	3	3	$A_1B_3C_3$
4	2	1	2	$A_2B_1C_2$
5	2	2	3	$A_2B_2C_3$
6	2	3	1	$A_2B_3C_1$
7	3	1	3	$A_3B_1C_3$
8	3	2	1	$A_3B_2C_1$
9	3	3	2	$A_3B_3C_2$

Tab. S3 The numerical of orthogonal tests

Experiment number	A	B	C	Intensity
1	1	1	1	32114.9648
2	1	2	2	37695.4023
3	1	3	3	27217.3379
4	2	1	2	61379.043
5	2	2	3	98131.2656
6	2	3	1	78702.1563
7	3	1	3	41187.8281
8	3	2	1	46402.5508
9	3	3	2	54434.8359
K_1	97027.705	134681.8359	157219.6719	
K_2	238212.4649	182229.2187	153509.2812	
K_3	142025.2148	160354.3301	166536.4316	
k_1	32342.56833	44893.9453	52406.5573	
k_2	79404.15497	60743.0729	51169.7604	
k_3	47341.73827	53451.44337	55512.14387	
R	47061.58614	15849.1276	3105.58657	
Primary and secondary order		A>B>C		
Excellent level	A_2	B_2	C_3	
Excellent combination		$A_2B_2C_3$		

As can be seen from Table S3, the order of factors affecting fluorescence intensity is A > B > C, and the best scheme is $A_2B_2C_3$. According to the above results, the optimum conditions for preparing N-CQDs are hydrothermal time of 6 h, temperature of 200 ℃ and gelatin dosage of 6 g.