Electronic Supplementary Material (ESI) for New Journal of Chemistry.

Supplementary material

Porous boron nitride nanoribbons with large width as superior adsorbents for the rapid removal of cadmium and copper ions from water

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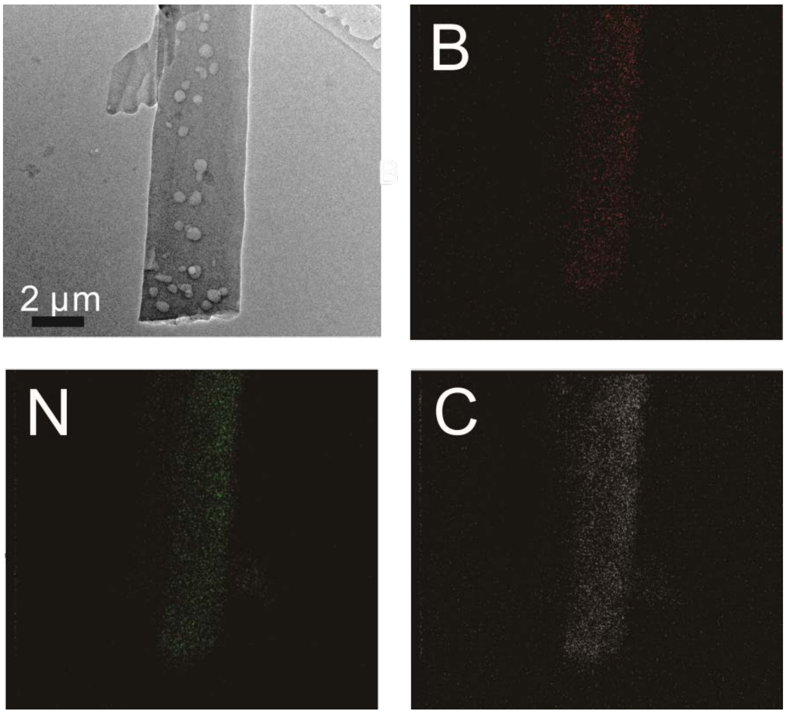

Fig. S1 The the mapping element of image of B, N, and C on BNNRs.

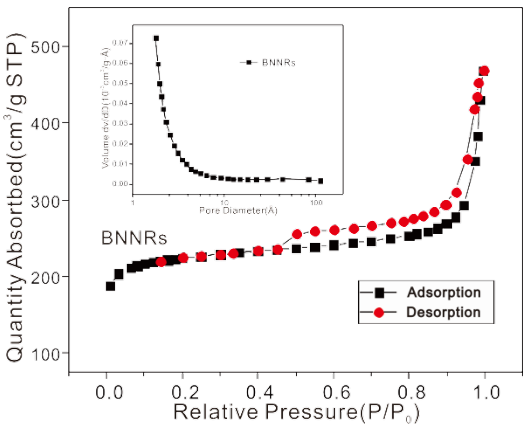

Fig. S2 The nitrogen adsorption-desorption isotherm of BNNRs, and inset is the pore-size distribution curve of BNNRs.

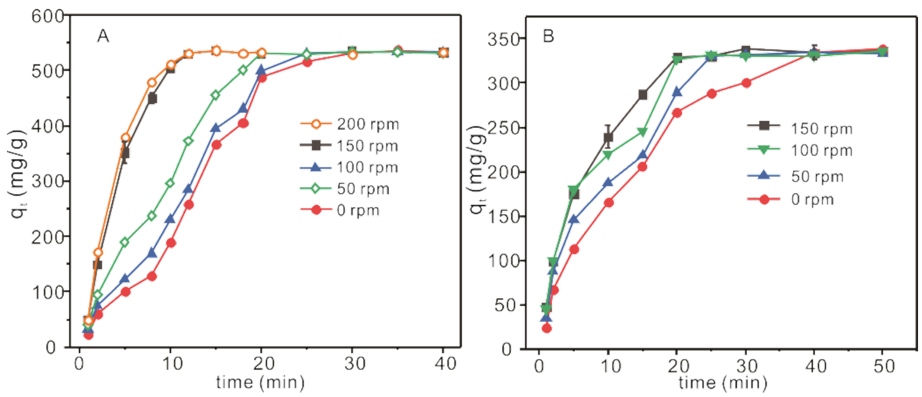

Fig. S3 The effect of equilibrium time on removal of cadmium (A) and copper (B) ions in stirring speed.

Table S1 Comparison of the adsorption capacity and of the reported boron nitride (synthesis temperature) for removal of heavy metal ions.

adsorbent sample	ions	synthesis temperature (°C)	adsorption capacity(mg/g)	Reference
cheese-like carbon boron nitride	Cd^{2+}	1100	482.1	[1]
nanosheet-structured boron nitride spheres	Cd^{2+}	1300	107.0	[2]
BNNRs	Cd^{2+}	550	530.0	this work
the urchin-like boron nitride	Cu^{2+}	1400	92.8	[3]
BNNRs	Cu^{2+}	550	331.0	this work

Thermodynamic Models

The standard free energy change (ΔG^0) is calculated from the following equation [4]:

$$\Delta G^0 = -RT\ln K^0$$

where R is the ideal gas constant (8.314 J mol^{-1} K^{-1}), K° is the adsorption equilibrium constant. Values of $\ln K^0$ are obtained by plotting $\ln K_d$ ($K_d = \frac{C_0 - C_e}{C_e} \times \frac{V}{m}$) versus C_e and extrapolating C_e to zero, the value of Y-axis is the value of $\ln K^0$.

The standard enthalpy change (ΔH^0) and the standard entropy (ΔS^0) are calculated from the plot of ln K^0 versus 1/T for Pb^{2+} adsorptions by the following equation [5432][2]:

$$\ln K^0 = \frac{\Delta S^0}{R} - \frac{\Delta H^0}{RT}$$

Calculation of thermodynamic data

The ln K_d as function of C_e at T = 298.15 K, 308.15 K and 318.15 K is given in Fig. S1. The Cd^{2+} adsorption equilibrium constants (K^0) at different temperature are obtained by linear extrapolating C_e to zero, ln K^0 = 2.15 at T = 298.15 K, ln K^0 = 2.29 at T = 308.15 K, and ln K^0 = 2.43 at T = 318.15 K, and ΔG^0 = −5.32 kJ/mol at 298.15 K, −5.86 kJ/mol at 308.15 K, and −6.42 kJ/mol at 318.15 K, respectively. The values of ΔH^0 and ΔS^0 can be obtained from the plot of ln K^0 vs. 1/T (Fig. S4A(inset)). The value of ΔH^0 and ΔS^0 is calculated to be 11.82 kJ/mol and 58.2 J/mol K, respectively. Similarly, The Cu^{2+} adsorption equilibrium constants (K^0) at different temperature are obtained by linear extrapolating C_e to zero, ln K^0 = 1.69 at T = 298.15 K, ln K^0 = 1.81 at T =

308.15 K, and ln K^0 = 1.89 at T = 318.15 K, and $\triangle G^0$ = -4.21 kJ/mol at 298.15 K, −4.62 kJ/mol at 308.15 K, and −5.00 kJ/mol at 318.15 K, respectively. The values of $\triangle H^0$ and $\triangle S^0$ can be obtained from the plot of ln K^0 vs. 1/T (Fig. S4A(inset)). The value of $\triangle H^0$ and $\triangle S^0$ was calculated to be 7.47 kJ/mol and 39.2 J/mol K, respectively.

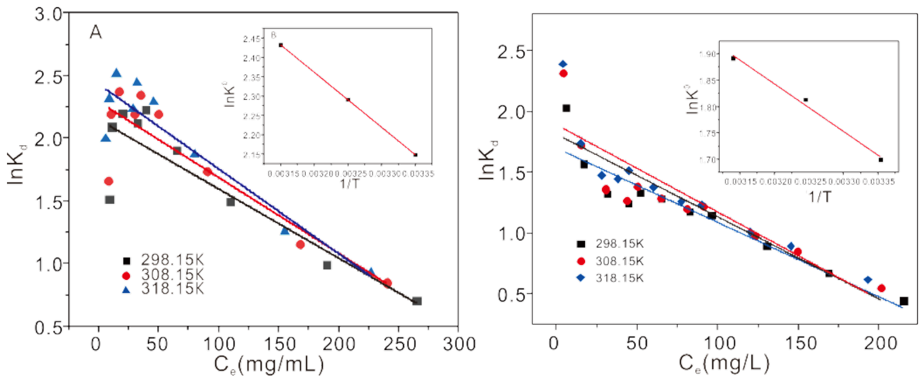

Fig. S4 Linear plots of lnK_d vs C_e for the adsorption of (A) Cd^{2+} and (B) Cu^{2+} ions ions on the BNNRs at 298.15, 308.15 and 318.15 K, (inset) Linear plot of lnK^0 vs 1/T for the adsorption of lead ions on the BNNRs at 298.15, 308.15 and 318.15 K.

Table S2 The thermodynamic parameters of removal Cd^{2+} and Cu^{2+} ions on the BNNRs.

	T (K)	ΔH^0 (kJ/mol)	ΔS^0 (J/mol)	ΔG^0 (kJ/mol)
	298.15	11.82	58.2	-5.32
Cd^{2+}	308.15			-5.86
	318.15			-6.42
	298.15	7.47	39.2	-4.21
Cu^{2+}	308.15			-4.62
	318.15			-5.00

References

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