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# Poly(acryloyl hydrazide)-grafted cellulose nanocrystal adsorbents with an excellent Cr(VI) adsorption capacity

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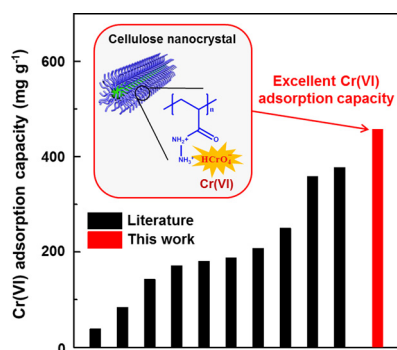
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## GRAPHICAL ABSTRACT



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## ABSTRACT

In this study, we prepared poly(acryloyl hydrazide) (PAH)-grafted cellulose nanocrystal (CNC-PAH) particles via the atom transfer radical polymerization method for application to Cr(VI) adsorption. The closely-packed PAH chains grafted on the cellulose nanocrystal (CNC) surface provide a high density of amine groups that can adsorb Cr(VI) through strong electrostatic, hydrogen bonding and chelating interactions. CNC-PAH exhibited the optimum Cr(VI) adsorption capacity at the solution pH = 3, where its electrostatic attraction with Cr(VI) was maximized. Cr(VI) was chemisorbed in CNC-PAH by following the Langmuir isotherm mechanism (homogeneous monolayer adsorption). The Cr(VI) adsorption kinetics of CNC-PAH was controlled predominantly by intra-particle diffusion resistance imparted by the PAH shell layer. Thermodynamic analysis revealed that Cr(VI) adsorption of CNC-PAH is a spontaneous and endothermic process. Importantly, CNC-PAH grafted with the higher  $M_w$  ( $\sim 50 \text{ kg mol}^{-1}$ ) PAH exhibited a rapid Cr(VI) adsorption rate and remarkably high Cr(VI) adsorption capacity ( $\sim 457.6 \text{ mg g}^{-1}$  at 298.15 K), exceeding those of previously reported adsorbents owing to its numerous Cr(VI)-adsorptive amine groups provided by the closely-packed grafted PAH polymers. Furthermore, CNC-PAH showed excellent reusability to maintain its high adsorption ability during repeated adsorption-desorption cycles owing to the covalently binding nature of the PAH polymers.

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