Journal of Hazardous Materials 394 (2020) 122512

Contents lists available at ScienceDirect

Journal of Hazardous Materials

journal homepage: www.elsevier.com/locate/jhazmat

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

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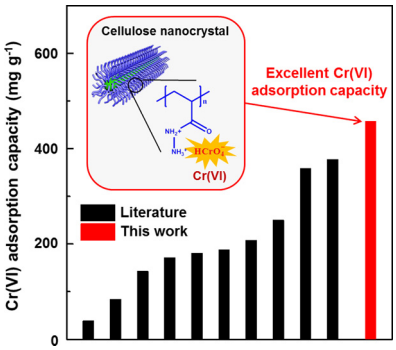
## GRAPHICAL ABSTRACT




## ARTICLE INFO

Editor: Daniel CW Tsang

*Keywords:*
Cellulose nanocrystal
Atom transfer radical polymerization
Adsorbents
Cr(VI) removal

## 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 $M_w$ (~50 kg mol$^{-1}$) PAH exhibited a rapid Cr(VI) adsorption rate and remarkably high Cr(VI) adsorption capacity (~457.6 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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https://doi.org/10.1016/j.jhazmat.2020.122512
Received 13 December 2019; Received in revised form 24 February 2020; Accepted 9 March 2020
Available online 10 March 2020