INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: Optimality of Commercial Resins and Functionalized Chitosan Derivatives for the Recovery and Reuse of Pd(II) from Synthetic Electroless Plating Solutions

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SHORT ABSTRACT

Adsorption based recovery, removal and reuse of noble metals from spent waste solutions is a challenging area of research. With data confining towards simpler aqueous solutions, the available literature does not elaborate towards Pd(II) adsorption and desorption characteristics associated to complex adsorbate systems. Further, comparative assessment of performance and cost indices is not available. With abundance of nitrogen functional groups and significant ability to undergo cross-linking with suitable functional groups, chitosan has been investigated to a moderate extent towards its efficacy for noble metal recovery and reuse from only aqueous solutions. In this regard, promising performance has been inferred by our research group with respect to glutaraldehyde based functionalized chitosan derivative. However, other derivatives including nitrogen and sulfur functionalized chitosan materials have not been addressed for their efficacy for Pd(II) recovery and reuse. Considering these lacunae, the PhD thesis addresses the efficacy of commercial and chitosan based resins for the recovery, removal and reuse of Pd(II) from synthetic electroless plating (ELP) solutions, which is characterized to have a moderate solution complexity.

Firstly, Pd(II) speciation in synthetic ELP solutions was evaluated using visual MINTEQ (open source) software. Further, appropriate modification of chitosan with suitable nitrogen or nitrogen and sulfur functional groups was achieved by adopting displacement and elimination reaction techniques. For all adsorbents, batch adsorption studies were carried for a variation in batch adsorption process parameters as 0.5−10 pH, 10-100 mg adsorbent dosage, 5-1080 min contact time and 50-300 mg L-1 Pd(II) initial solution concentration. For comparative assessment, the adsorptive and desorptive performance of all resins was also evaluated for Pd(II) aqueous solution systems at corresponding optimized batch process parameter values. For the resin-synthetic ELP solution system, the experimentally evaluated batch equilibrium, kinetic and thermodynamics of Pd(II) adsorption were evaluated for their fitness with suitable equilibrium (Langmuir and Freundlich models), kinetic (Pseudo-first-order, Pseudo-second-order and intraparticle diffusion models) and Van't Hoff thermodynamic model respectively. The desorption efficiencies of all the adsorbents were carried out using simple and cheaper eluents at the concentration range from 0.1−2 M for the spent adsorbents obtained with 50 mg L-1 initial Pd(II) solution concentration. Finally, cost effectiveness of all the adsorbents were targeted by evaluating cost indices based on the retail costs associated to their fabrication for synthesized resins and retail cost of commercial resins.

Among all adsorbents, commercial Amberlyst A21 resin can be inferred to have excellent performance characteristics from adsorption, desorption and cost perspectives. Besides these, the carried out investigations enabled useful insights into the irrelevance of HSAB theory as a generalized rule of thumb to screen and scope potential adsorbents for noble metal recovery and reuse. In summary, the thesis provided useful insights into the desorption and cost efficacy perspectives of studied resins and thereby provides the necessary framework to further enhance the applications of adsorption technology towards noble metal recovery and reuse from complex adsorbate systems such as real waste water samples.