Preparation and Characterization of CMC/HA-NPs/Pulp Nano-Composite for the Removal of Heavy Metal Ions

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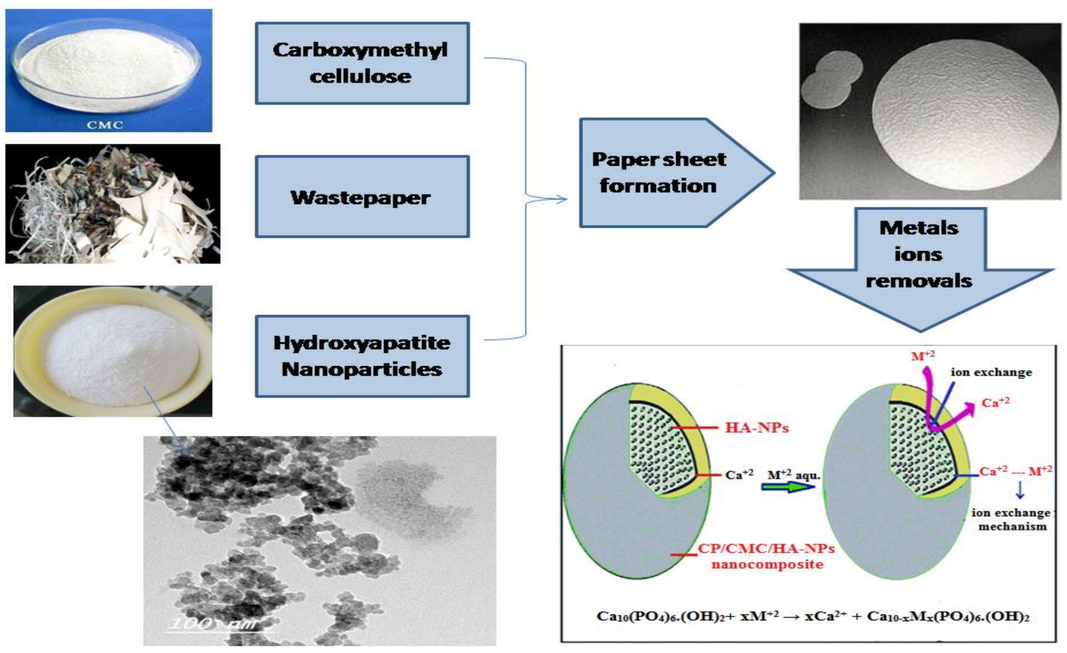
Abstract

The paper sheets nanocomposite of cellulose pulp/ carboxymethyl cellulose/ hydroxyapatite nanoparticles were prepared with different ratios of HA-NPs. Also the effects of the prepared paper sheets nanocomposite in the removal of Fe^{2+}, Cu^{+2} and Cd^{2+} ions were studied. Two types of cellulose pulps were used in this investigation, the recycled wastepaper pulp (RWP) and the bleached wood pulp (BWP) to prepare RWP/CMC/HA-NPs and BWP/CMC/HA-NPs, respectively. The hydroxyapatite nanoparticles as well as the paper sheets nanocomposite were characterized using different techniques. In addition, the swelling of the paper sheets nanocomposite in aqueous solutions were studied, where it decreased by increasing the HA-NPs content in the paper sheets. The mechanical properties of the BWP treated with HA-NPs were higher than that in RWP. It was also found that, the ratio of removal heavy metal ions was increased by increasing the ratio of HA-NPs in the paper sheets nanocomposite.

Methods



Results

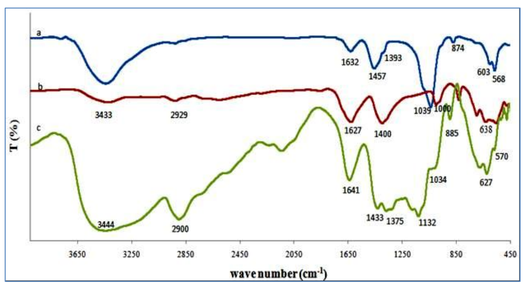
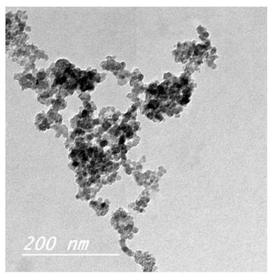


Fig. 1: FT-IR spectrum of HA-NPs (a), CP/CMC paper sheet (b) and CP/CMC/HA-NPs paper sheet nanocomposite (c)

Highlights

- Waste reduction
- Waste paper recycling
- Heavy metal removal
- Enhancing the mechanical properties of paper
- Inorganic filler materials



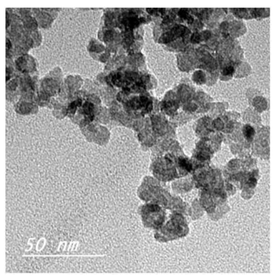


Fig.3:TEM image of HA-NPs at two different magnification

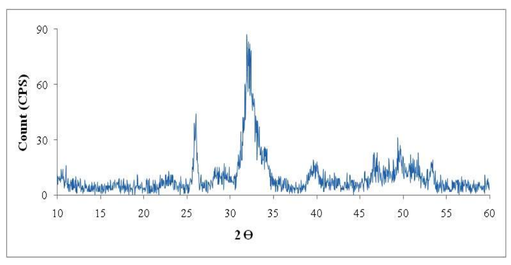


Fig. 2: XRD diffraction pattern of hydroxyapatite nanoparticles

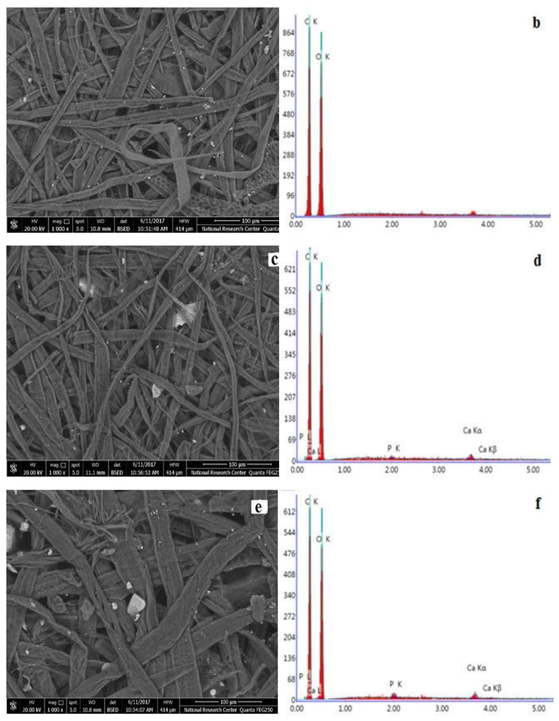


Fig.4: SEM image of CP/CMC (a), RWP/CMC/HA-NPs (c), BWP/CMC/HA-NPs(e) and their corresponding EDEX (b, d and f), respectively

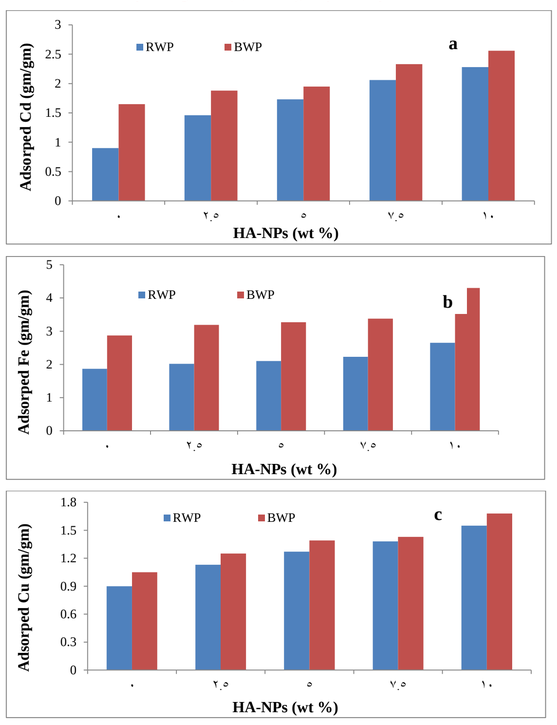


Fig. 6: The effect of various loadings of HA-NPs in RWP/CMC/HA-NPs and BWP/CMC/HA-NPs paper sheets nano-composites on adsorption of a) cadmium ions, b) iron ions and c) copper ions

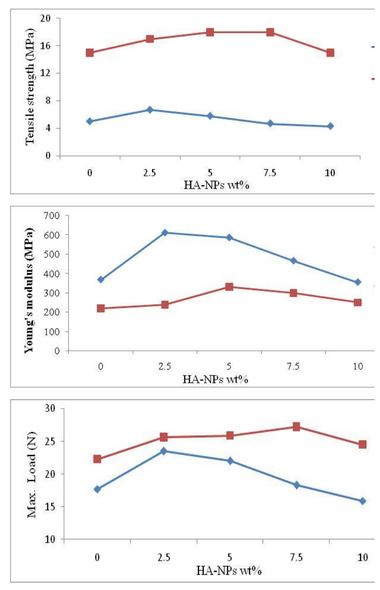


Fig.5:The impact of various loadings of HA-NPs in RWP/CMC/HA-NPs and BWP/CMC/HA-NPs paper sheets nano-composites on (a)Tensile Strength (MPa), (b) Young's modulus (MPa) and (c) Max. Load (N)

Table 1: Water absorption behavior of RWP/CMC with HA-NPs paper sheets

Sample no.	HA-NPs Wt.%/RWP	Water absorption %
1	0.0	458
2	2.5%	389
3	5%	368
4	7.5%	357
5	10%	289

Table 2: Water absorption behavior of BWP/CMC with HA-NPs paper sheets

Sample no.	HA-NPs Wt.%/BWP	Water absorption %
1	0.0	345
2	2.5%	285
3	5%	263
4	7.5%	258
5	10%	254

Conclusions

Addition of hydroxyapatite nanoparticles (HA-NPs) greatly improved the mechanical properties and water absorption ability of the treated paper sheets. The enhancement was extended to the removal of Cd, Fe and Cu ions.

Bibliography

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