TRIBOLOGY AND RHEOLOGY OF HYALURONIC ACID BASED CELLULOSE NANOCRYSTAL SUSPENSIONS

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ABSTRACT

Hyaluronic acid (HA) is an unbranched mucopolysaccharide with repeating units of N-acetylglucosamine and glucuronic acid glycosidic linkage. Due to the biomechanical properties of HA, it is used in a wide range of biomedical applications, especially as a friction or viscosity modifier. The current study investigates the microstructural, tribological and rheological properties of HA based cellulose nanocrystals (CNC) suspensions.

The microstructural characterization of the CNC suspensions was performed using a polarized optical microscope (POM). The POM images revealed the presence of chiral nematic domains of CNCs where their size increase with an increase in CNC concentration (due to the intermolecular hydrogen bonding (H-bond) between the CNCs). The tribological measurements were performed using a pin-on-disk tribometer. Using a steel-steel tribo-pair, results showed a reduction in the coefficient of friction and wear with the addition of only 0.5 wt.% CNC to HA. The energy-dispersive X-ray spectroscopy (EDX) revealed that the addition of CNCs reduced the surface corrosion of the tribo-pair. At higher CNC concentrations, the COF value tends to increase, due to the abrasive behaviour of the large CNC agglomerates. Rheological measurements were performed using a rotational rheometer. The steady shear viscometry data of HA/CNC suspensions exhibited shear thinning behaviour at lower shear rates due to the alignment of CNC agglomerates along the shear direction. The frequency sweep data revealed that the solid-like viscoelastic behaviour (storage modulus greater than loss modulus) of HA/CNC suspension increased with an increase in CNC concentration. The HA/CNC suspension with CNC concentration of 1 wt % and more exhibit yielding behaviour. The yield stress of the suspensions increases with CNC concentration. These findings may serve as an initial step in developing HA/CNC-based rheology or tribology modifiers for different biomedical and pharmaceutical applications.