

## **Process optimization of ultra-high molecular weight polyethylene/cellulose nanofiber bionanocomposites in triple screw kneading extruder by response surface methodology**

### **ABSTRACT**

Incorporation of nanocellulose could improve wear resistance of ultra-high molecular weight polyethylene (UHMWPE) for an artificial joint application. Yet, the extremely high melt viscosity of the polymer may constrict the mixing, leading to fillers agglomeration and poor mechanical properties. This study optimized the processing condition of UHMWPE/cellulose nanofiber (CNF) bionanocomposite fabrication in triple screw kneading extruder by using response surface methodology (RSM). The effect of the process parameters—temperature (150–190 °C), rotational speed (30–60 rpm), and mixing time (30–45 min)—on mechanical properties of the bionanocomposites was investigated. Homogenous filler distribution, as confirmed by scanning electron microscopy-energy dispersive spectroscopy (SEM-EDS) analysis, was obtained through the optimal processing condition of 150 °C, 60 rpm, and 45 min. The UHMWPE/CNF bionanocomposites exhibited improved mechanical properties in terms of Young's and flexural modulus by 11% and 19%, respectively, as compared to neat UHMWPE. An insignificant effect was observed when maleic anhydride-grafted-polyethylene (MAPE) was added as compatibilizer. The obtained results proved that homogenous compounding of high melt viscosity UHMWPE with CNF was feasible by optimizing the melt blending processing condition in triple screw kneading extruder, which resulted in improved stiffness, a contributing factor for wear resistance.

**Keyword:** Ultra-high molecular weight polyethylene; Cellulose nanofiber; Bionanocomposite; Response surface methodology; Optimization; Melt-blend processing