Physically Treated Cellulose and Its Use in Composites

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Abstract

In this study, treated cellulose was characterised using Fourier transform infrared spectroscopy and thermal analysis to assess the effects of ultrasound on its chemical structure and thermal stability. After this treatment, the treated cellulose was used as a filler in composite materials. To evaluate the effectiveness of this approach, the resulting composites were analysed in terms of their rheological behaviour as well as their mechanical properties, providing insight into the influence of ultrasound-based physical treatment on the overall composite performance.

Material

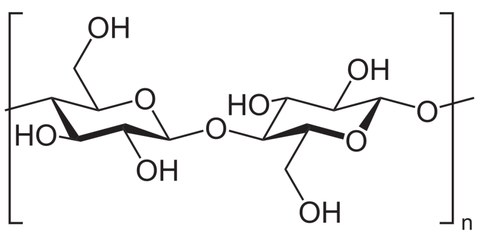

Fig. 1 Structure of cellulose

Physical treatment of cellulose

Cellulose was pre-soaked in distilled water for 24 hours and then ultrasonically treated as 1 wt.% and 4 wt.% suspensions for 4 hours at 35 kHz using a Bandelin DT 106 sonifier. The treated cellulose was subsequently filtered and dried at 105 °C for 48 hours.

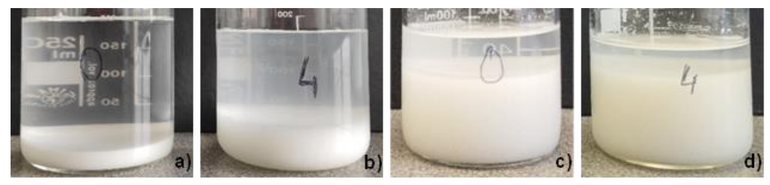

Fig. 2 Sedimentation observation after 24 hours: (a) 1% cellulose solution untreated, (b) 1% cellulose solution after 4h ultrasonic treatment, (c) 4% cellulose solution untreated, (d) 4% cellulose solution after 4h ultrasonic treatment

Results

Characterisation of physically treated cellulose

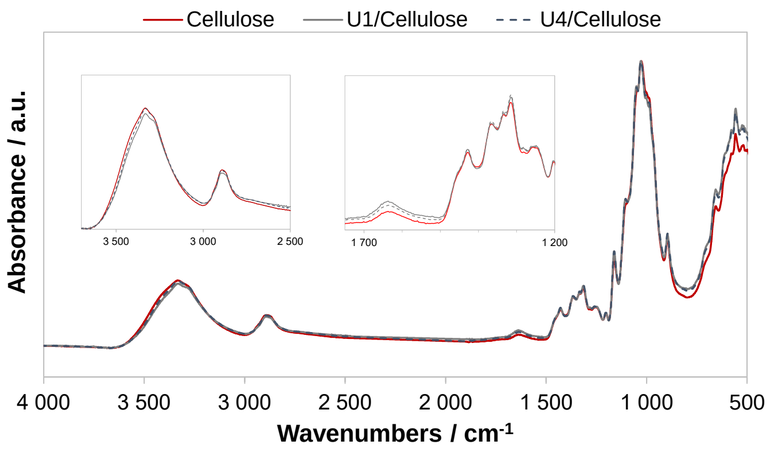

Fig. 3 FTIR of Cellulose, U1/Cellulose and U4/Cellulose

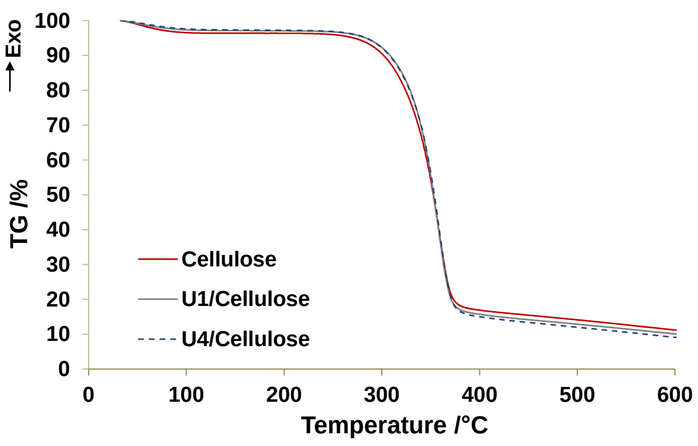

Fig. 4 TG curves of Cellulose, U1/Cellulose and U4/Cellulose

Rheological behaviour and mechanical properties

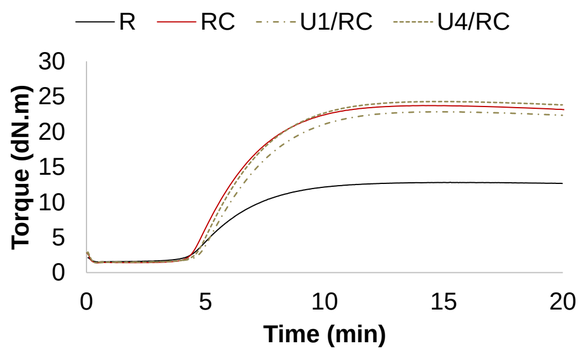

Fig. 5 Curing curves of composites

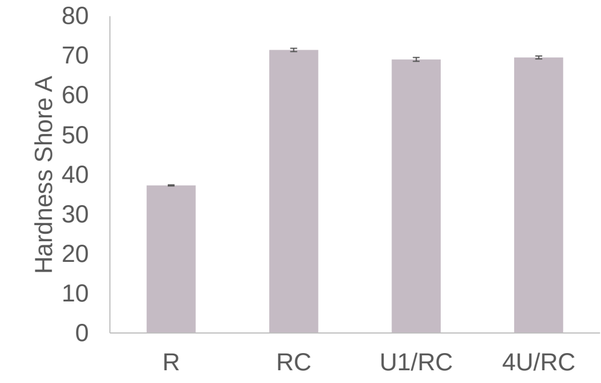

Fig. 6 Hardness of composites

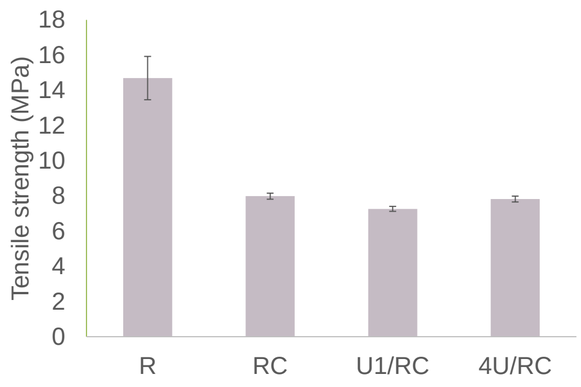

Fig. 7 Tensile strength of composites

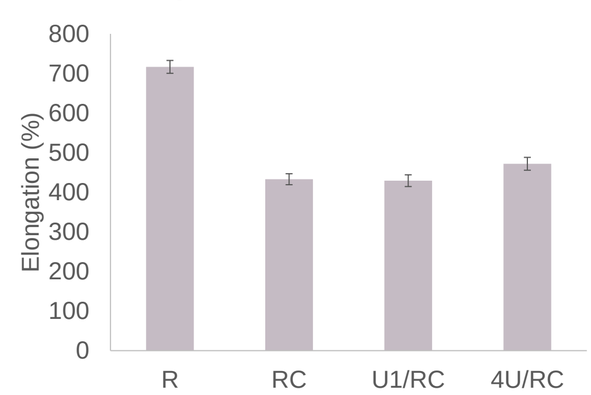

Fig. 8 Elongation of composites

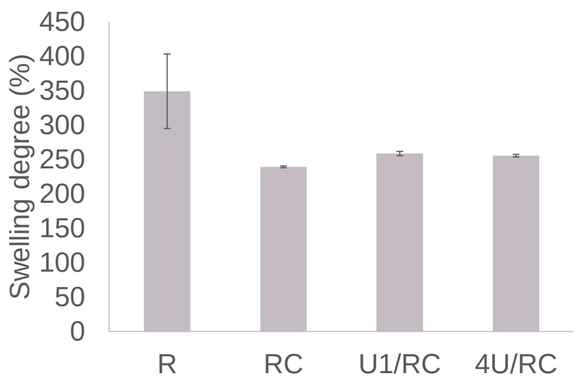

Fig. 9 Swelling degree of composites

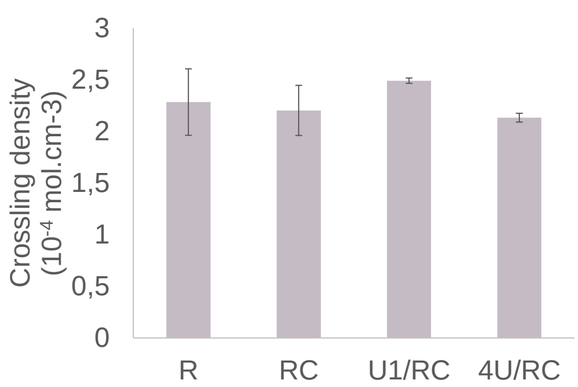

Fig. 10 Tensile strength of composites

Conclusion

This study investigated the effect of ultrasonic physical treatment on the properties of cellulose and rubber composites containing it as a filler. Ultrasonic treatment of cellulose has been shown to enhance its compatibility with the rubber matrix, resulting in composites that exhibit higher hardness, reduced swelling, and marginally improved mechanical properties when compared to composites containing untreated cellulose.

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