**Table 2.** Mechanical properties (Young's Modulus, elongation at break, tensile stress) of each composite

| | Young Modulus (GPa) | Tensile (MPa) | Elongation at break (%) |
|---|---|---|---|
| **TOCN/PPy-1** | 1.81 ±0.33 | 28.7 ±2.1 | 3.09 ±0.39 |
| **TOCN/PPy-2** | 2.52 ±0.28 | 42.5 ± 5.4 | 2.55 ±0.14 |
| **TOCN/PPy-3** | 6.35 ±0.91 | 65.6 ±0.5 | 1.81 ±0.49 |

## 4 Conclusion

Flexible TOCN/PPy films were prepared by three different methods and their properties were evaluated. The chemical polymerization of pyrrole on surface of TOCN films shows the best mechanical and thermal properties. The results revealed a significant effect of TOCN film on the improvement of the mechanical properties of TOCN/PPy. The PPy layer allowed an increase in hydrophobic character of the composite. On contrary, TOCN/PPy-1 presented the worst mechanical properties due to the low number of interactions between cellulosic fibers. This method which consists to the polymerization in situ of pyrrole around the fibers, have demonstrated a better conductive capacity than TOCN/PPy-3. Thus, PPy particles distribution can be detrimental for the films mechanical properties. From our proposed methods, the grafting of N-(3-aminopropyl)pyrrole was really interesting because it presented intermediate properties of all composites, and could be a good compromise between the mechanical and electrical properties. So we can conclude that the method used directly influences the composite conductivity and PPy particles distribution is detrimental for the films mechanical properties. Thus, for electrical applications such as in batteries, capacitors, sensors or solar cells for example, the use TOCN/PPy-1 and TOCN/PPy-2 seem to offer the best match but for flexible electrodes, TOCN/PPy-3 appears to be the best.

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