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Supplementary Information: TiNAgNW Nanocomposites on Nanocellulose for Enhanced Flexible Electrodes based on wrinkled Titanium Nitride Nanocomposites deposited on TEMPO-Oxidized Nanocellulose

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Citation: Gence, L.; Quero, F.; Escalona, M.; Wheatley, R.; Seifert, B.; Diaz-Droguett, D.; Retamal, M.J.; Volkmann, U.; Bhuyan, H. Supplementary Information: TiNAgNW Nanocomposites on Nanocellulose for Enhanced Flexible Electrodes based on wrinkled Titanium Nitride Nanocomposites deposited on TEMPO-Oxidized Nanocellulose. *Nanomaterials* **2024**, *1*, 0. https://doi.org/

Received:
Revised:
Accepted:
Published:

Supplementary information

CNP Characterization

The characterization of the synthesized cellulose nanopaper (CNP) and TEMPO-oxidized CNP is presented in figure 2. Cellulose structure can vary greatly depending on the synthesis parameters that impact the proportion of amorphous domains and its chemical stability. The pulp had a solid content of 13.7 wt. % and an α-cellulose content of 90.2%. Its sugar composition was 74.2 % of glucans, 14.8 % of xylans and 0.8 % of arabinans among other constituents as quantified by high performance liquid chromatography. 2,2,6,6-Tetramethylpiperidine 1-oxyl (TEMPO) (98 %), NaClO (12 % solution), NaBr and NaOH ($\geqslant$ 99 %) were purchased from Merck-Sigma Aldrich. All chemicals were used as received without further purification.

Powder XRD, Fourier transform infrared spectroscopy (FTIR), as well as thermogravimetric, and derivative weight loss curves (DTG) data are given for CNP and Tempo treated CNP samples, in figure 2. The XRD data show a principal diffraction peak positioned at $2\theta = 22^o$, which correspond to the (200) diffraction plane. A single peaks is observed at $2\theta = 16^o$, which is surprising since some literature suggests that two peaks located at $2\theta = 14.9^o$ and $2\theta = 16.7^o$ are normally seen and corresponds to the (1-10) and (110) diffraction planes, respectively. It has been suggested that a single diffraction peak could be explained for crystallite with diamond-shaped cross section [1]. A small diffraction peak was recorded at $2\theta = 35^o$, and corresponds to the (004) diffraction plane. This suggests the cellulose is in its Iβ crystalline form which is typical for plant cellulose [2].

As expected, the FTIR data presented in figure 2 allowed identifying the presence of carboxylate moieties for CNP TEMPO when compared to CNP due to presence of an absorption peak located at a wavenumber position of 1610 cm^{-1} related to the vibrational motions of carbonyl moieties that belong to the molecular structure of carboxylate. This chemical modification is used to improve the production of individual and monodisperse nanofibers, and results in an increase in the optical transmittance of CNP substrate in the visible region [3].

With respect to TGA traces, one can observe a significant decrease in thermal stability for CNP Tempo compared to CNP. This suggests that CNP and CNP TEMPO substrates have to be exposed to adequate temperature conditions so as to avoid their thermal degradation upon applying further processing or fabrication steps.

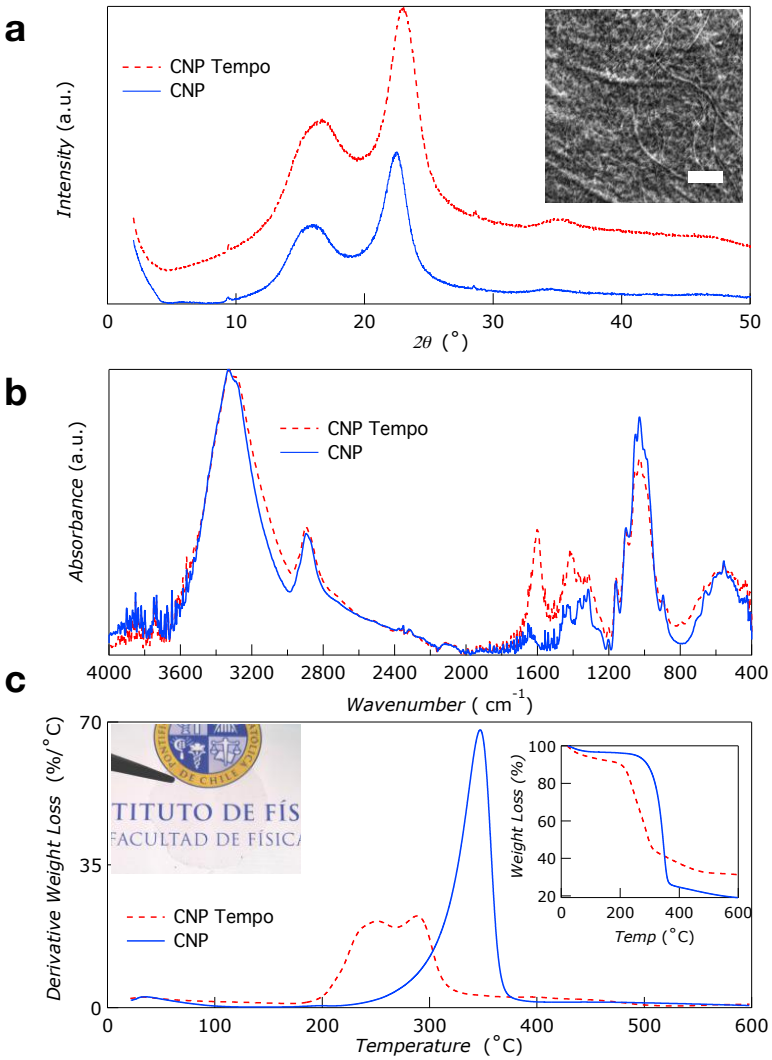

Figure 1. a) XRD data for CNP and Tempo Samples. The peak at $2\theta = 22^o$ indicates the presence of the crystalline region. The Inset shows a TiN-coated CNP substrate. b) FTIR Absorbance for CNP and Tempo treated CNP samples. c) Derivative Thermogravimetry (DTG) of CNP and CNP Tempo samples. The inset gives the corresponding TGA curves and a picture of a pristine CNP substrate.

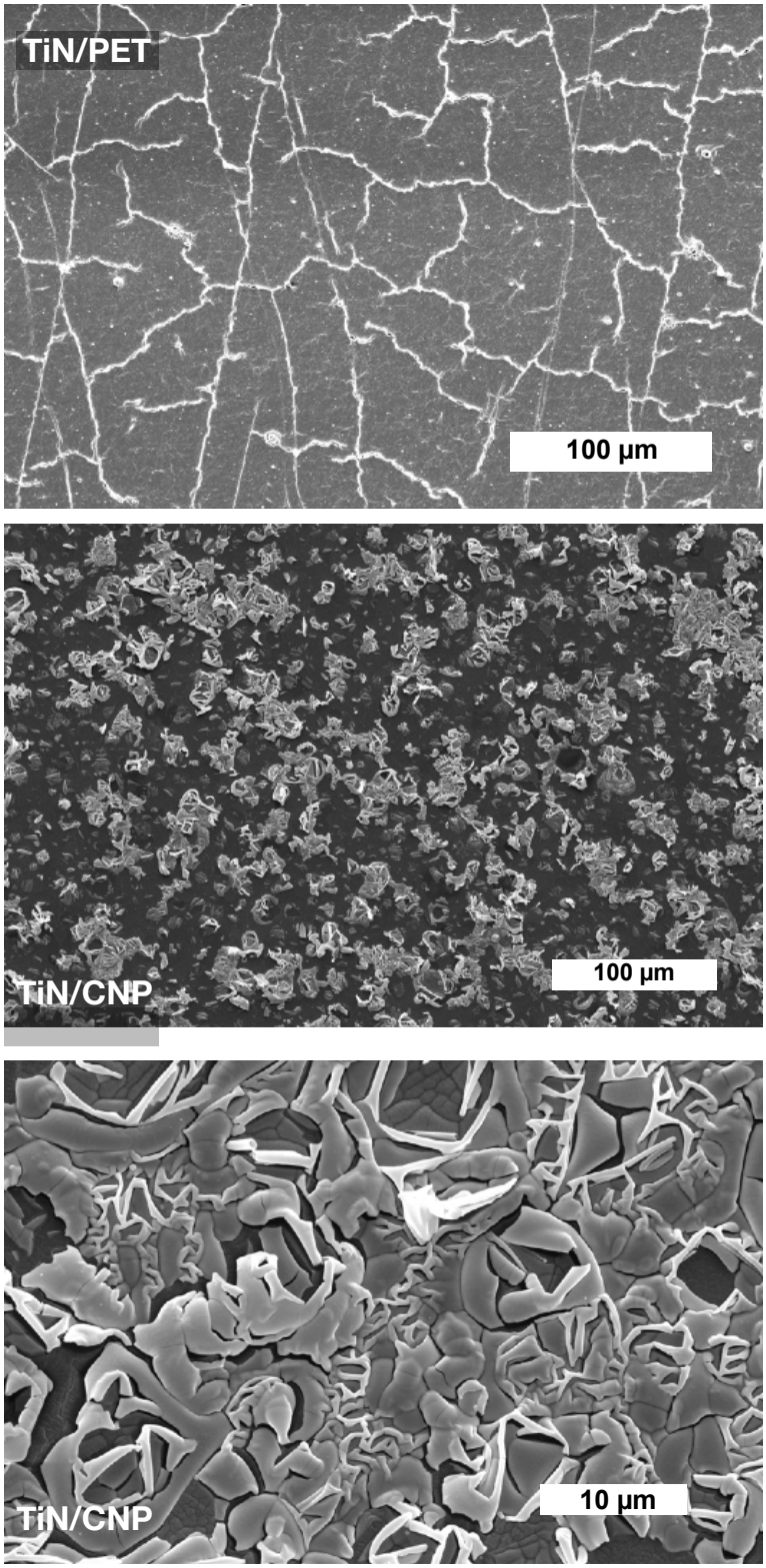

Figure 2. SEM images of TiN coatings on CNP and PET substrate deposited at elevated temperature (T>200^{o}C).

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