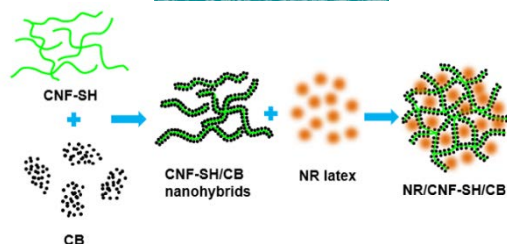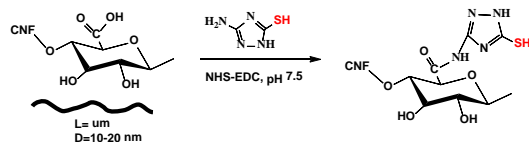**Ge ZHU**

Ph.D. thesis (2018-2021)
LGP2 (Alain Dufresne)

Conductive natural rubber/carbon black nanocomposites via thiol-modified cellulose nanofiber templated assembly
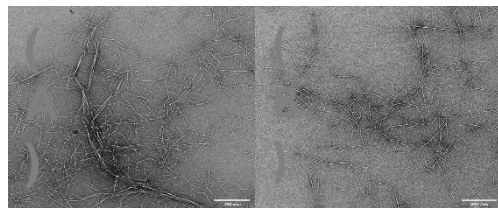
MatBio

Context

CNF-SH + CB → CNF-SH/CB nanohybrids + NR latex → NR/CNF-SH/CB

we developed a simple and effective strategy to fabricate carbon black(CB) based 3D hierarchical conductive structures in a natural rubber matrix using thiol-modified CNF(CNF-SH) as templates.

CNF + H₂N-triazole-SH, NHS-EDC, pH 7.5

L= um
D=10-20 nm

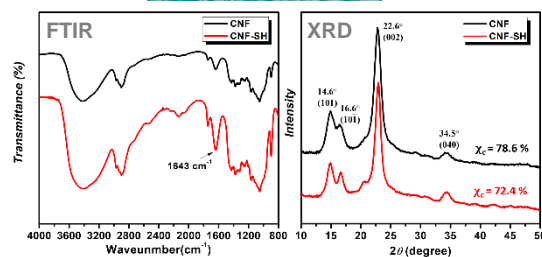*Thiol-modified CNF were prepared through the carboxylation−amidation reaction.*

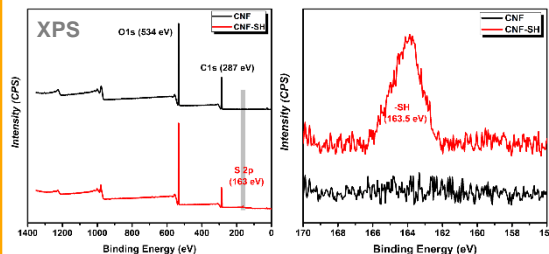

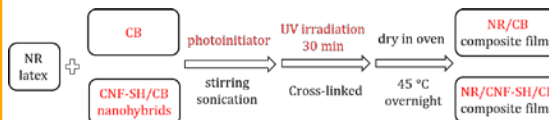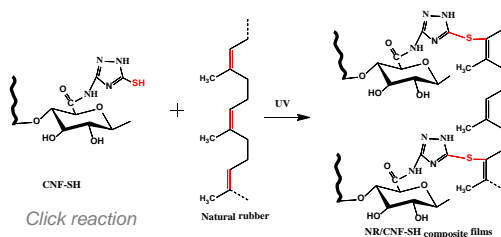*The CNF and CNF-SH exhibit a typical fibrous morphology.*

Funded by

Methods

FTIR — CNF / CNF-SH; 1643 cm⁻¹

XRD — CNF / CNF-SH; 22.6° (002); 14.6° (101); 16.6° (101); 34.5° (040); χ_c = 78.6 %; χ_c = 72.4 %

The modification didn't destroy the surface hydroxyl group and crystal structure.

XPS — CNF / CNF-SH; O1s (534 eV); C1s (287 eV); S 2p (163 eV); -SH (163.5 eV)

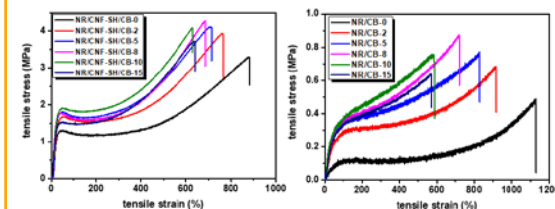*It shows the successful attachment of the thiol group to the CNF by elemental analysis and XPS results.*

NR latex + CB + CNF-SH/CB nanohybrids → stirring sonication → photoinitiator, Cross-linked → UV irradiation 30 min → dry in oven 45 °C overnight → NR/CB composite films / NR/CNF-SH/CB composite films

Preparation of the NR/CNF-SH/CB and NR/CB composites

CNF-SH + Natural rubber → UV → NR/CNF-SH composite films

Click reaction

Results

all of the NR/CNF-SH/CB samples exhibit higher tensile strength and Young's modulus than the neat NR/CB composites.

The NR/CNF-SH/CB films showed a much lower electrical conductivity percolation threshold than the NR/CB composites.

We proposed a simple, facile, and environmentally friendly approach, CNF-SH-assisted self-assembly of CB in the NR latex, to prepare highly sensitive, stretchable and reversible strain composites with a 3D hierarchical conductive network structure.
The construction of a 3D network significantly enhanced the electrical properties and reduces the electrical percolation threshold of the composites.