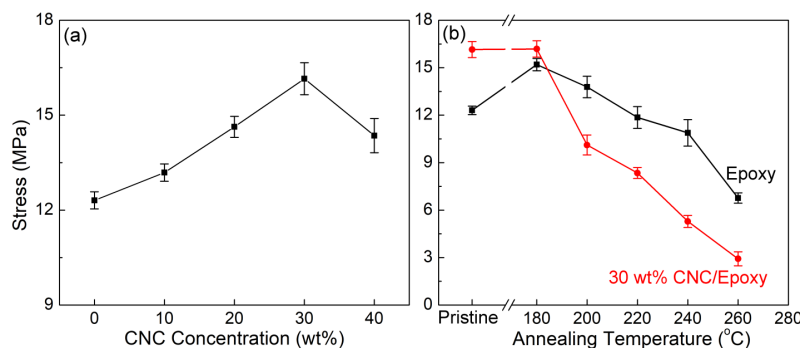


CNCs as Degradable Elements in Thermoset Materials

This project is aimed at developing a thermally-degradable adhesive based on a cellulose nanocrystal (CNC)/epoxy nanocomposite. The CNC acts as mechanical reinforcement during normal working conditions, but at elevated temperature, the adhesive breaks down and is easily removed. By introducing the CNCs, a major reduction in the breakdown temperature ($\sim 50^{\circ}\text{C}$) is achieved, together with a clean separation. The target application has been in downhole tool adhesives, however, the concept is being explored for other applications and materials systems.



RECIPIENT:

**NRC-
Nanotechnology
Research Centre -
Ken Harris/Andrew
Myles**



TOTAL BUDGET:

\$390,000



PROJECT DATES:

**September 2018 –
December 2020**



PARTNERS:

InnoTech Alberta



AI FUNDING:

\$300,000



PROJECT TRL:

**Start: 3
End: 5**

APPLICATION

Thermoset materials cross-link during formation to create a solid structure. They are widely used as adhesives, protective coatings, building elements, electrical insulation and many others. A major problem, however, is removal after use, so this project aims to address this issue by developing thermally-degradable CNC/thermoset composites.

ALBERTA INNOVATES CLEAN RESOURCES

BIOINDUSTRIAL INNOVATION

BIOMATERIALS PURSUIT

PROJECT GOALS

- Complete the development of a robust CNC/epoxy nanocomposite formulation that retains the adhesive strength of the epoxy together with a ~50°C reduction in the thermal breakdown temperature and an irreversible change in the composite material's properties as to allow easy removal.
- Develop a fundamental understanding of the thermally-induced breakdown mechanism to enable refinements and optimization.
- Build on the new knowledge to identify and develop additional CNC composite materials systems and open new application areas with other thermoset materials.

BENEFITS TO ALBERTA

- Alberta has a wealth of untapped biomass resource. Developing high value applications of this biomass would improve the diversity of the Albertan economy.
- CNC has been identified as one of the most promising value-added applications for the biomass resources in Alberta.
- The aim is to bolster Alberta's bio-industrial sector by developing commercial prototypes based on CNC composites.
- The initial technical target is based on a known industrial need: an adhesive that is strong and reliable yet also easily degradable for part separation and reuse/recycling.
- The project highlights applications of CNCs, and it compliments Alberta's investment in scaling up CNC production.
- Bringing advanced technologies to commodity markets is another major advantage.



2-3 Publications



**2 Students
Trained**



1-2 Patents



**1-3 New
Products/Services**



1-4 Future Jobs



5 Project Jobs

CURRENT STATUS

APRIL 2020

The mechanical properties of CNC/epoxy composites have been thoroughly evaluated for a wide range of CNC loading fractions and thermal treatments. The thermal breakdown mechanism has been identified and supported with experimental evidence. Patent protection has been completed. NRC led commercialization activities are progressing, and partners are being identified. The process is now being explored for new materials systems.