Cellulose-based triboelectric nanogenerators

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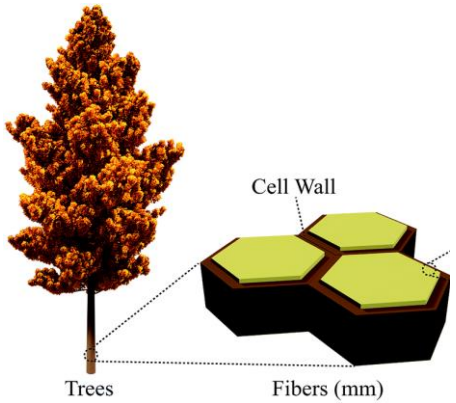
WARF
Wisconsin Alumni Research Foundation

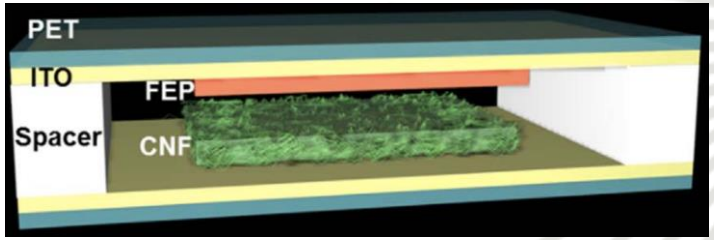
Smart Buildings

- Four goals:
  - **Scavenging energy** from ambient sources
  - **Powering sensors** without the need of batteries
  - Using only **environmentally friendly** materials
  - Ensuring **robust operation** with limited mechanical complexity

TENG powerboards for Smart Buildings

- UW-Madison patented Cellulose nanofibril (CNF)-based nanogenerators
- Made from agricultural waste products





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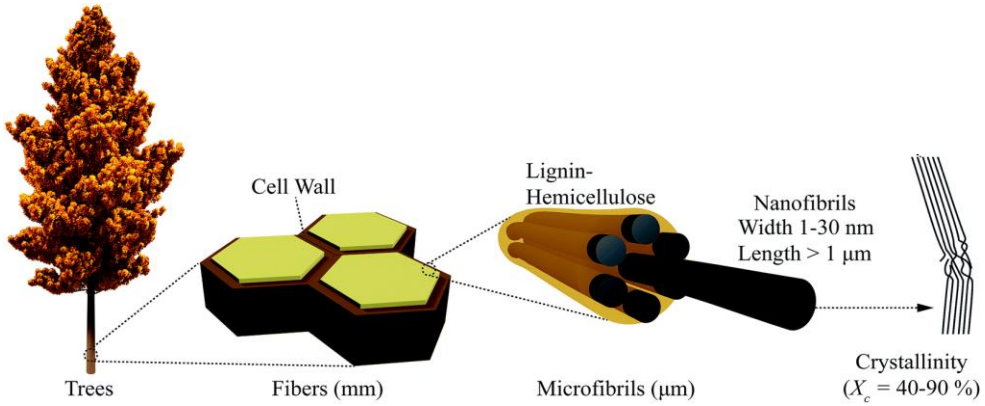
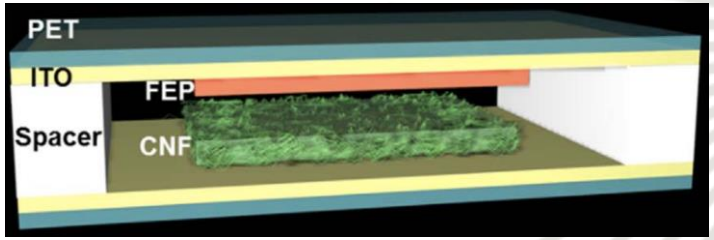


CNF films



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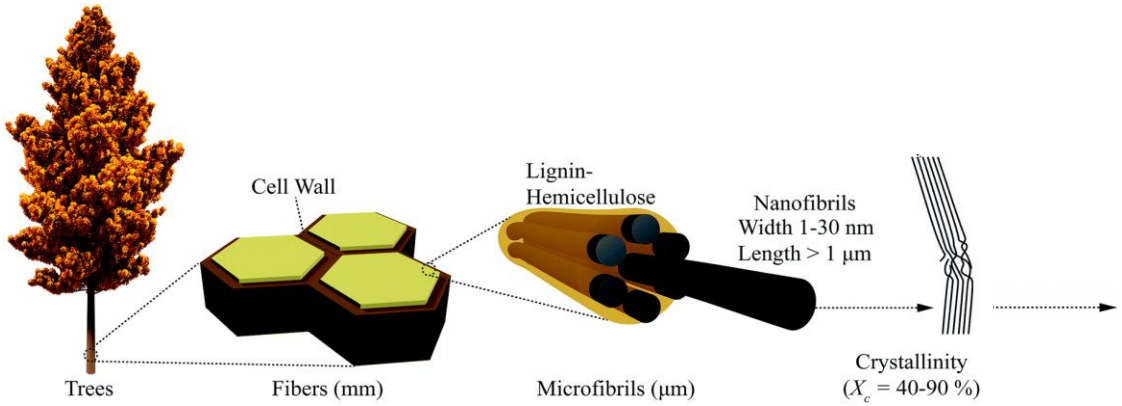
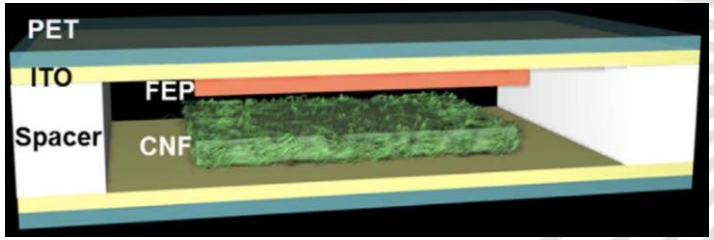
TENG powerboards for Smart Buildings

- UW-Madison patented Cellulose nanofibril (CNF)-based nanogenerators
- Made from agricultural waste products
- Using thin, commercially available CNFs
- CNF films functionalized → triboelectric nanogenerators (TENGs)



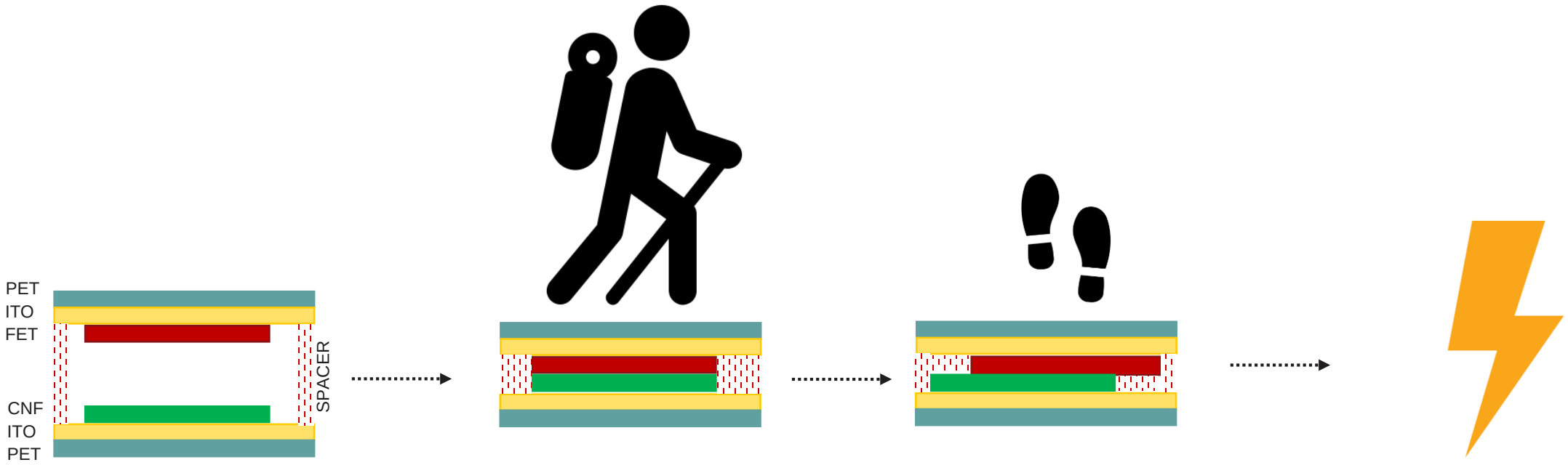
CNF films

Patented



TENG

TENG power generation from friction



TENG Field Testing

- 1 step lights 35 green LEDs
- Electricity generation = 8.3 % efficiency, ~30V, 90 uA

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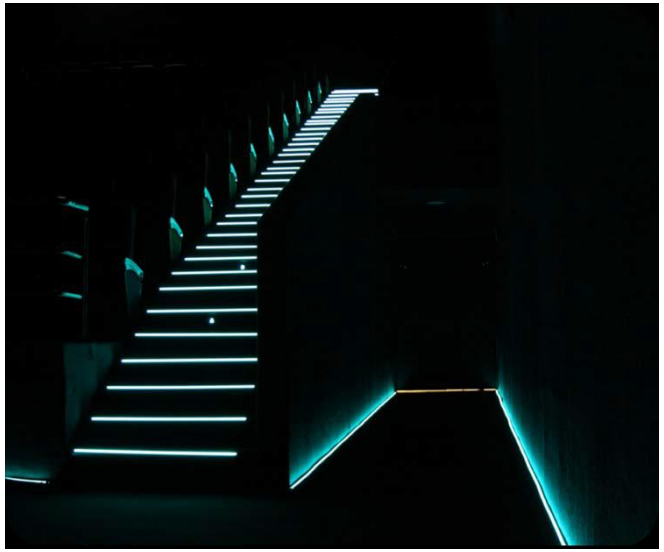
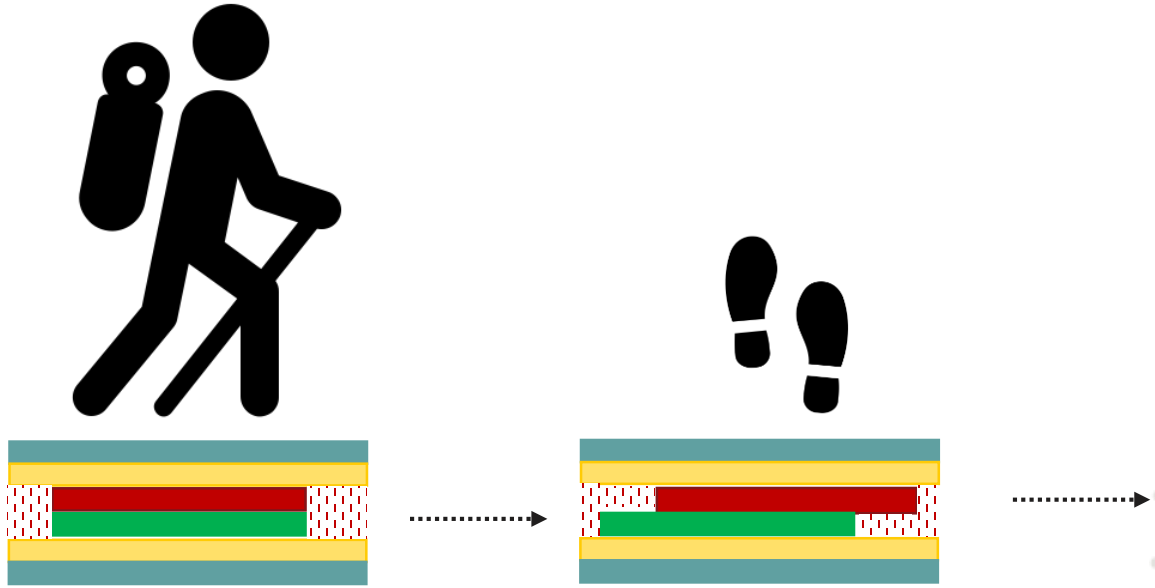
- Robust energy generator
- Flooring in high traffic area
- 4 months: 1,170,033 footsteps

Patented, funded by WARF + NSF iCorps + SBIR I + etc

US patent 1,0277,147

Potential applications: demonstrated through field testing

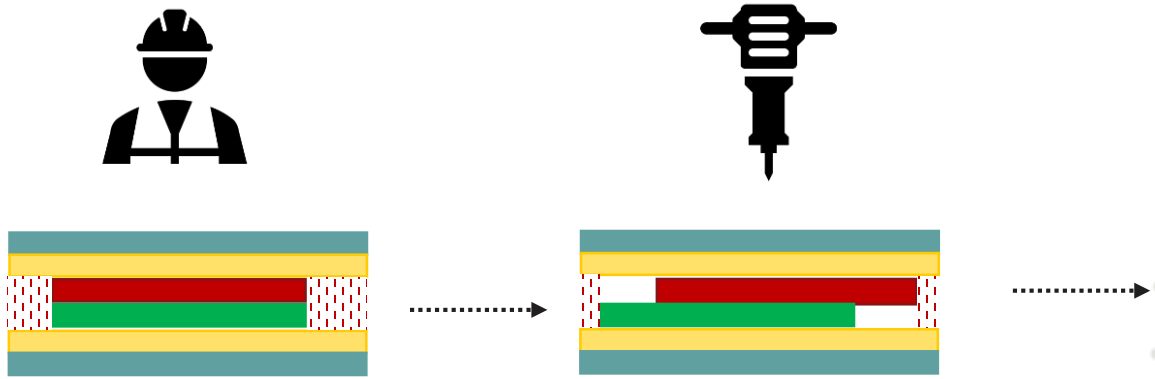


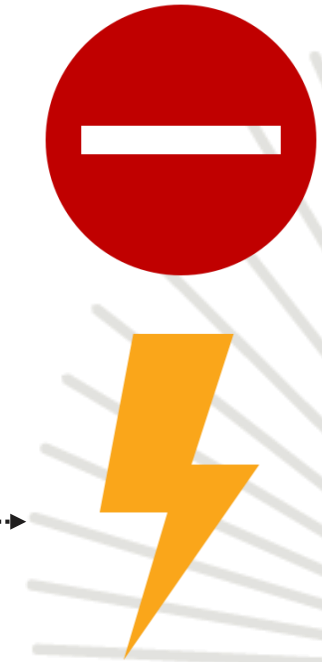


Smart floors

- **Retail**
- **Sports analytics**
- **Healthcare smart sensors**
- **Pedestrian space designs**
- **Intrusion alarm**

Potential applications

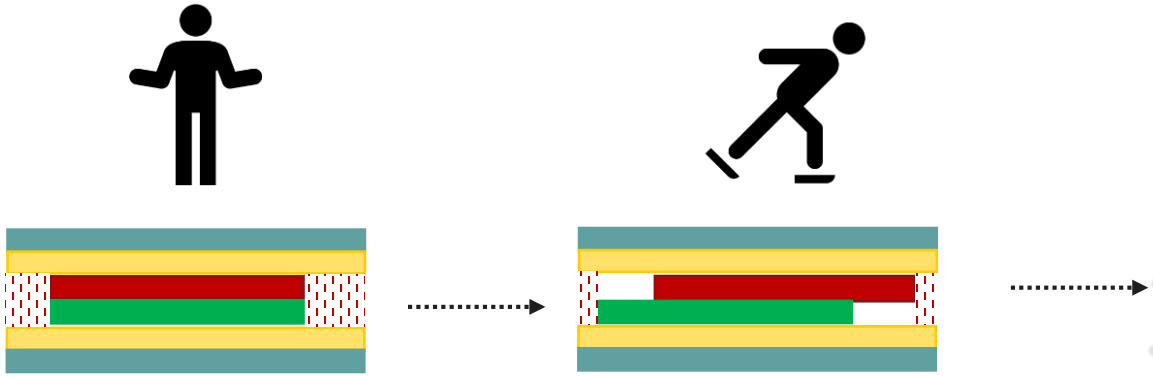




Sensors and security

- **Structural stability alarm**
- **On/Off Sensor**
- **Activity sensor**

Potential applications

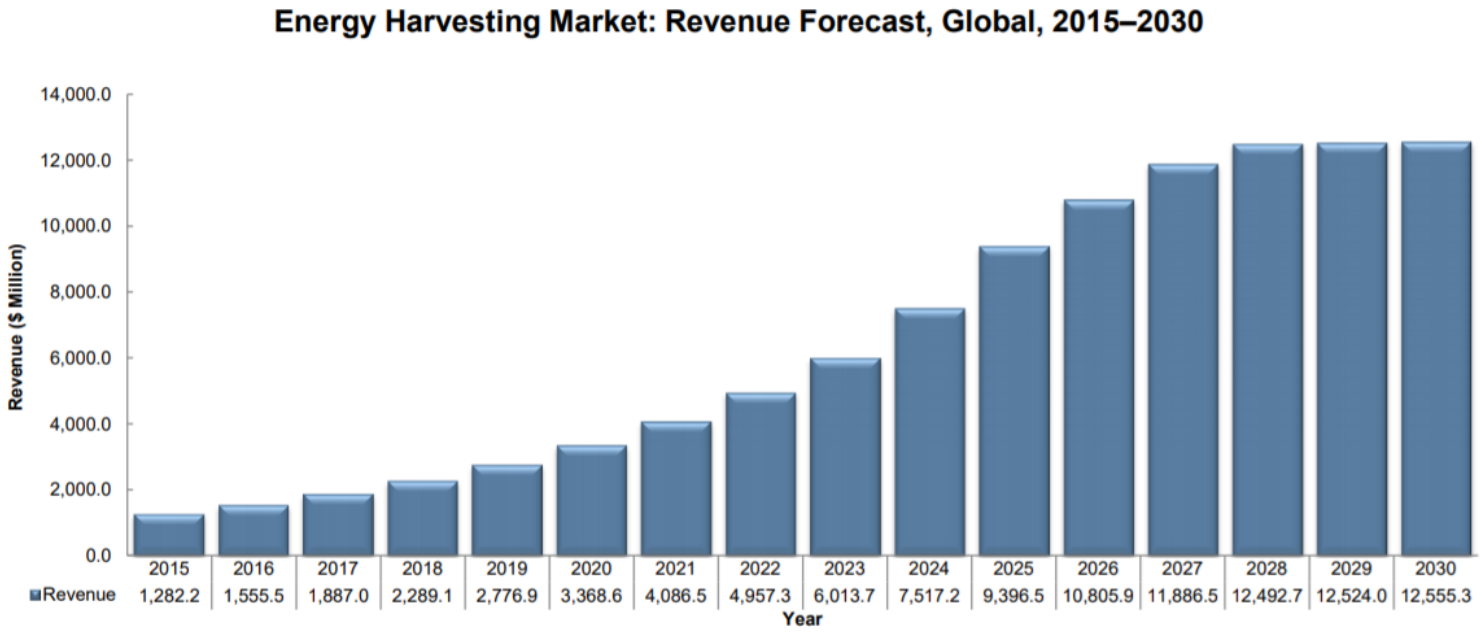


Smart clothing

- **Activity**
- **Injury**

Nascent energy harvesting market is forecast to be worth $12.5B in 2030

- Revenues in 2015 were estimated to be $1.28B



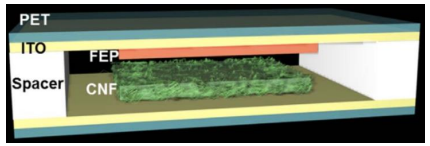
- Primary drive: providing self-powered sensors for smart energy and transport networks as well as for smart industries
- Piezo/triboelectric technologies forecast to account for the 3rd largest market segment in revenues

The opportunity

Seeking commercial collaborators and investments

- Basic Technology Research
- Research to Prove Feasibility
- Technology Demonstration (Lab Scale)
- Technology Development & Prototypes
- Pilot Test & Scale-up
- Market Launch & Commercialize

TRL 1 TRL 2 TRL 3 TRL 4 TRL 5 TRL 6 TRL 7 TRL 8 TRL 9



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