Roll-to-Roll manufacturing of transparent conductive CNB films
Shaping surfaces into experiences
Canatu in Brief

• A developer and manufacturer of 3D formable and flexible transparent conductive films and touch sensors
• Based on a new type of carbon nanomaterial: Carbon NanoBud® (CNB™ product family)

BACKGROUND
Canatu Oy Founded 2004, business operations started 2008
Over 40 FTE today
Headquarters: Konalankuja 5
FI-00390 Helsinki
Finland

IPR
Over 100 patents and applications across 13 patent families
Built on groundbreaking research from Aalto university

CUSTOMERS
Over 150k units delivered since 2015
Targeting and serving customers in:
• Automotive
• Consumer electronics

SUSTAINABILITY
The NanoBud® films are greener than traditional materials in production, use and recycling.
ISO 9001 certification since 2014

AWARDS RECOGNITIONS
• 2017: Startup Autobahn of Daimler
• 2014: Component of the Year Silver Award
• 2013: Technology Breakthrough award
Awards and recognitions

ISO 9001 certified
• We are committed to consistency, continual improvement and customer satisfaction. Canatu has been ISO9001 certified since 2014, and this year our certificate was updated into the ISO9001:2015 standard.

Awards
• 2017: Participation at Startup Autobahn innovation project of Daimler
• 2014: SID Display Component of the Year, Silver Award
• 2013: Technology Breakthrough award by Tekes
Global sales, local presence

**Headquarters**
Helsinki, Finland

**Sales locations**
Global Sales
Europe
US
Greater China, Taiwan
Japan
Korea
Enabling Design Freedom

Design Freedom
- Any Shape (3D)
- Any Surface

Intuitive User Experience
- Tactile by Form
- Visual quality and appearance

Enabled by Superior Technology
- Formable to shapes
- Display readability
Application examples

3D multitouch
• Several fingers simultaneously

3D finger guides
• Combining form & touch

3D touch door controllers
• For window lifting, other controls

Smart switches
• For lighting solutions
**CNB™ Films and Touch Sensors**

**CNB™ Free Form Film**
- For applications with touch on 3D surface
- Polycarbonate base substrate

**CNB™ Curve Film**
- For applications with touch on curved (2.5D) surfaces
- PET base substrate

**CNB™ Sensors**
- Consists of CNB Free Form or CNB Curve Films
- Sensors can be
  - bent to curved forms
  - formed to 3D shapes
  - back-molded or laminated to displays and other background illuminators or surfaces
Superior Technology

Based on ground-braking research
- NanoMaterials Group at Aalto University
- IPR fully owned by Canatu
- Enables conductive films for touch devices

Formable to shapes
- Stretchable (200%)
- Thermoformable (1mm radius)
- Moldable (robust)

Display readability
- Through high optical performance
- Low reflectivity for true black
- High contrast for true colors
- Crisp image with zero haze
- Transparent

CNBs are flexible, they fall in a curved and curled manner on the substrate, and they slide over each other.
CNB™ Film properties
Canatu Sensors based on CNB Free Form Film can be thermoformed into extreme shapes

- Highly stretchable
  - Carbon NanoBud stretches more than 200%
  - Maximum stretch rate depends on PC substrate
- Tight bending radius
  - Carbon NanoBud bending radius <1 mm
- Standard industrial thermoforming processes are supported:
  - Vacuum forming
  - Pressure forming

Data for CNB sheet resistivity vs stretch rate, for 250 µm PC substrate, high pressure thermoforming. Data here is obtained from a test device below.
Sensor stretch in applications

CNB sensor on flat or curved display

- For window radii 250 mm, 500 mm, 750 mm on display long side:
- CNB sensor stretch around 6%, 1.4%, 0.6% for a ~13” display, 16:9
- Can be easily managed, considering some line resistance increase

CNB sensor on touch switches on tightly bended areas

- Tightest radii can be 3 mm or lower
- Very high local stretch rates >100% -> locally significant resistance increase
- With proper sensor design, total line resistance does not necessarily increase much

Example of a high aspect ratio thermoformed part.
Can Film Insert Mold (FIM = IML)

- Touch Sensors with CNB Free Form Film are designed for Film Insert Molding
  - Aka IML = In Mold Labeling
  - 3D shapes with sensor stretching supported
  - Can be back-molded after thermoforming
  - Both 1-layer and 2-layer Sensors
- Standard industrial injection molding techniques
- Molding resins supported:
  - Polycarbonate (transparent)
  - PMMA (transparent)
True White

- CNB Film is color-neutral, almost flat transmission spectrum
- White color from display does not get distorted in the sensor

Substrate normalized CNB:

\[ a^* = 0 \pm 0.1 \]
\[ 0 < b^* < 1 \]

Color space for CNB Free Form and Curve Films:

\[ a^* = 0 \pm 0.1 \]
\[ b^* = 1.2 \pm 0.2 \]

Note: CNB and ITO transmissions are substrate normalized.
Deep Black and High Contrast

- A study of contrast of optimized 2-layer CNB sensor compared to standard ITO sensor
- Shows improved contrast under various lighting conditions

Vehicle standard J-1757: 2000 lux ambient, 1000 cd/m² glare
High transmittance

- CNB Film and Sensor transmittance correlates with sheet resistivity

**Gen B/Gen 6:**

50 Ω/□ at 90%
100 Ω/□ at 95%
150 Ω/□ at 97%
270 Ω/□ at 98%

This is substrate-normalized transmission:

\[ T = 100\% - \text{CNB Absorbance} \]
Manufacturing
Canatu invented new process
Direct Dry Printing®

- High purity gaseous synthesis of Carbon NanoBud material
- Aerosol printing of Carbon NanoBud material directly on substrate => CNB Film
- Roll to Roll, Roll to Sheet, or Sheet to Sheet
- Benefits:
  - High performance films as deposited
  - Scalable to high volumes
  - Green process: no wet or toxic chemistry
Competitive and scalable CNB Film production

Roll-to-Roll Direct Dry Printing® (in-situ patterning)

Direct dry printing makes it easier and cheaper to produce
Simple one step roll-to-roll aerosol printing on substrate without residues

Canatu’s Roll to Roll capability in Helsinki

In house manufacturing capability
CNB Film mass production equipment

Step and Repeat CNB deposition platform

- Substrate film handling in roll format, web width 610 mm... 650 mm
- CNB is selectively deposited on film material, deposition area max 600 mm x 600 mm
- Deposition area can be tailored by customer case (e.g. in any shape/multiple smaller areas)
- Film thickness 100 µm ... 250 µm, various plastic materials which are delivered in roll format
- Continuous in-line quality control
CNB Film mass production equipment

Step and Repeat CNB deposition platform

- High level of automatization
- Modular structure, capacity can be gradually increased
- Using proven Direct Dry Printing technology
- No heat exposure on the substrate film
- Wide and easily adjustable CNB sheet resistance range, starting from 50 ohms/sq

- Additional coating units on top of CNB deposition can be integrated to the same line
- Flexibility for piloting, small series and mass manufacturing
- Versatile protective liner lamination with possibility to change liners during the process
Canatu’s points of interest at the conference

- High accuracy web control system
  - Tension
  - Steering
  - Speed
- Cost effective coating method for protective coatings
  - Thickness < 0.5 µm
  - Uniform layer
- Automatic handling system for thin and sensitive film
- On line measurement systems
  - Non contact method
  - High resistance material (>1000 ops)
  - Low resistance material (<100 ops)
  - Transmission measurement through multi layer material
Thank You!