Shaping surfaces into experiences
Current challenge

Current automotive displays are neither intuitive to use, nor seamless

Canatu enables curved and 3D formed displays with touch everywhere

flat
clunky

large
intrusive

integral
seamless

intuitive
safe
Canatu invented new material
Carbon NanoBud®

Carbon NanoBud® material

Hybrid of Carbon Nanotubes (CNTs) and Fullerenes ($C_{60}$)

<table>
<thead>
<tr>
<th>Carbon NanoBud® material</th>
</tr>
</thead>
<tbody>
<tr>
<td>NanoBuds are highly conductive</td>
</tr>
<tr>
<td>Deposited as a scarce random network on substrate</td>
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<tr>
<td>NanoBuds do not reflect light</td>
</tr>
<tr>
<td>NanoBuds are flexible, they are deposited in a curved and curled manner on substrate, and they slide over each other</td>
</tr>
</tbody>
</table>
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
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
Touch module applications with CNB sensors
3D multi-touch over display

- Bonded to seamless front window with decoration
- Multitouch
- 2 CNB layers
- Touch buttons, sliders etc. can be integrated on the same sensor sheet, e.g. around display
- Thermoformed into desired free 3D form
- Back-molded 3D formed lens (FIM, IML)
- OCA or LOCA bonded to display
Helsinki factory

Manufacturing in 1200 m² factory space in Finland
Possible interfaces

3D multitouch
3D finger guides
3D touch door controllers
Smart switches
The Canatu’s NanoBud® films are greener to produce, use and recycle than traditional technologies.

- Manufacturing processes require less raw materials as the organic carbon is completely recyclable.
- The thin form offers lighter structures with energy savings, less material consumption, and greater space utilization.
Global sales, local presence

Headquarters
Helsinki, Finland

Sales locations
Global Sales
Europe
US
Greater China, Taiwan
Japan
Korea
Thank you!
Key automotive trends

**USER EXPERIENCE**

- Multimodal touch and voice user interaction
- Manufactures seeking for intuitive and non-distractive user interface
- Intuitive
  - Formable to shapes
  - Bendable with 1mm radius
  - Stretchable up to 200%

**ELECTRIC**

- Longest driving distance a key competitive advantage
- Manufactures seeking for energy saving, thin and light constructions
- Great heat dissipation
  - Energy saving
  - Light, sleek
  - Environmental friendly

**AUTONOMOUS**

- Cars are becoming a connected living rooms
- Manufacturers differentiate based on innovation, quality and versatile interior designs
- Seamless, sleek design
  - Natural, no distraction
  - Robust
  - Moldable
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

Over 100 patents and applications across 13 patent families

Headquarters: Konalankuja 5 FI-00390 Helsinki Finland

**IPR**

Over 100 patents and applications across 13 patent families

Built on ground-breaking 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 to produce, use and recycle than traditional materials.

ISO 9001 certification since 2014

**AWARDS RECOGNITIONS**

- 2017: Innovative Door Control at 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. For that we hold ISO 9001 certification since 2014.

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
Superior Technology

Formable to shapes
• Stretchable (200%)
• Thermoformable (1mm)
• 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.
Truly unique technology

**Canatu is the only touch technology** viable for both **thermoforming** and **injection molding** with high performing transparency

<table>
<thead>
<tr>
<th>Implementation Experience</th>
<th>Pedot</th>
<th>Metal Mesh (MM)</th>
<th>Silver Nanowire (AgNW)</th>
<th>ITO</th>
<th>Canatu’s Carbon Nanobud®</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blueish, long term reliability, high resistivity</td>
<td>Low stretch, limited forming, mesh visibility, higher haze and prone to moiré effect</td>
<td>Low stretch, limited forming, issues with ESD and UV reliability, higher haze</td>
<td>No stretching, no over molding</td>
<td>Stretchable up to 200%, thermoformable with 1mm radius, moldable with high performing transparency (no haze, contrast or reflection)</td>
<td></td>
</tr>
</tbody>
</table>
CNB Touch Sensor Manufacturing Process

This process is for 1-layer touch sensor.

- CNB Synthesis and Deposition (DDP)
- Silver conductor printing
- Laser ablation for fine pattern
- Overcoat printing
- Touch Module integration
3D Touch Module Manufacturing Process

- CNB Sensor Sheets Tx and Rx
  - CNB Sensor Tx and Rx sheet OCA bonding or co-lamination
  - Deco Film printing
- 2D CNB Touch Sensor
- 2D Touch-Deco Window
  - Deco film to Sensor OCA bonding
- 3D Formed Touch Window
  - Deco+Sensor stack thermoforming
- 3D Touch Module
  - Formed Deco+Sensor stack to Lens backmolding
  - LOCA bonding to Display
- 3D Touch Display

Touch-Deco window manufacture

FIM process

Display integration

Process for 3D stack with:
- Deco Film on A-side
- 2-layer FF/2F sensor on A-side
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.
Competitive benchmarking for CNB™ Free Form Film

Stretching of Conductive Films

- CNB (gen 5.5)
- PEDOT:PSS
- AgNW