SWITCH Materials Inc.

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Project Coordinator
What are Smart Windows?

- Windows that change light transmission properties in response to heat, light or electricity
- Alter the amount of light and solar heat entering the building
- Optimize use of natural light and solar thermal energy with building management systems
Why Smart Windows?

- Renewable energy sources cannot meet projected demand
- Solutions focused on energy efficiency become critical
Why Smart Windows?

Buildings: consume 39% of all energy produced, and 68% of all electricity. Windows are a significant factor in building energy efficiency, accounting for up to 30% of building energy loss.

Smart windows can save energy on heating, cooling, and lighting. They improve occupant comfort (black body radiation, glare).
Why Smart Windows?

- Solar Heat Gain Coefficient- approx. 49% from the visible spectrum, 51% from the IR spectrum
- Low-E windows have reached the theoretical maximum amount they can reduce SHGC
- Improve comfort; reduce black body radiation and glare
**Smart Window Market (2017*)**

<table>
<thead>
<tr>
<th>Advanced Glass</th>
<th>Solar Control</th>
<th>Smart Window</th>
</tr>
</thead>
<tbody>
<tr>
<td>US $9,000</td>
<td>$2,900</td>
<td>$540</td>
</tr>
<tr>
<td>WW $65,000</td>
<td>$19,500</td>
<td>$3,600</td>
</tr>
</tbody>
</table>

- **Advanced Glass**
  - Other Advanced
  - e.g. fire rated safety self cleaning

- **Solar Control**
  - Other Solar
  - e.g. low-E reflective spectral

- **Smart Window**
  - Arch
  - Auto
  - Other

*forecast in millions $US, source Freedonia, Pilkington NSG

**16% CAGR vs. industry average 5%**

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- Ions flow between electrodes
- Metal oxides deposited onto glass
- Three active layers
- Examples: Gentex electrochromic mirrors; Sage Windows
Current Technologies - SPD

- Suspended Particle Device
- Similar to LCD
- Expensive, difficult to process
- Example: Research Frontiers

Mercedes “Magic Sky” sunroof
- Changes in response to temperature
- No wiring required
- No user control
- Dependent on
  - building orientation
  - window construction
  - ambient temp
- Example: Pleotint
Opportunity

Performance

*Installed price incremental to low-E IGU @ $100 per ft^2

- **< $50**
  - **Least**
  - **Block Visible**
    - Blinds, Curtains
    - Spectrally Selective: Bekaert, Southwall, CP
  - **Block NIR**
  - Smart Window
    - SPD Film: Res Frontiers
    - Electrochromic: Sage, Soladigm, Chromogenics

- **$50 to $100**
  - **Most**
  - External Shading Systems

- **$100+**
  - **Least**
  - **Block Visible**
    - Blinds, Curtains
    - Spectrally Selective: Bekaert, Southwall, CP
  - **Block NIR**
  - Smart Window
    - SPD Film: Res Frontiers
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- Hybrid photo-electrochromic films
- Single active hybrid layer
- Darkens automatically in sunlight to reduce SHG
- Switch clear with an applied electrical charge
Roll-to-Roll Manufacturing

- Cost-efficient roll-to-roll coating
- Target cost to channel of $130/m²
Smart Window Demonstrations

- Support from BC ICE Fund, and SDTC
- First real-world deployment of SWITCH hybrid smart windows
- Install SWITCH windows in two locations for 6 to 12 months:
  - BCIT School of Energy building
  - Lighthouse Sustainable Building Centre
BCIT Construction

24.7mm (1”)

6mm Tempered clear float

Pressure Sensitive Adhesive

6mm Solarban 70

SWITCH hybrid smart film

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Lighthouse Constructions

Existing 3mm clear glass

Pressure Sensitive Adhesive

3mm Solarban 70

SWITCH hybrid smart film
Lighthouse In Action
Energy Impact Monitoring

BCIT SW2 HVAC

- 263 Duct Temp (SAT)
- 263 Room Temp
- 257 Duct Temp (SAT)
- 257 Room Temp

Temperature (deg C)

5 10 15 20 25 30
Occupant Feedback

- "On sunny days it feels cooler"
- "We used to turn the blinds to prevent glare on our computers and my office mate occasionally felt uncomfortably warm. We didn’t use the blinds once the smart windows were installed"
- "Love that I can see my computer screen all day without blinds"
Occupant Feedback

- “During summer we found ourselves opening the window to let warm air in”
- “The windows made the office too dark and green”
Challenges

- Long-term durability, photostability
- Colour balancing, contrast ratios
- User-interaction, building energy management
Thanks for Listening!
Questions?
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