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**BEST 1**  
CONFERENCE  
Building Enclosure Science & Technology

## Laboratory Calibration and Field Results of Wood Resistance Humidity Sensors

**Kohta Ueno**  
Building Science Corporation

BEST 1: Building for Energy Efficiency and Durability at the Crossroads  
June 10-12, 2008 Minneapolis, MN



University of Waterloo  
**BEG** Building Engineering Group  
University of Waterloo, Waterloo, Canada

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## Background

- High humidity environments in building enclosure monitoring
- Relative humidity sensor durability problems
- Relative humidity vs. capillary saturation (i.e., liquid water) resolution
- Wood moisture content-based sensor

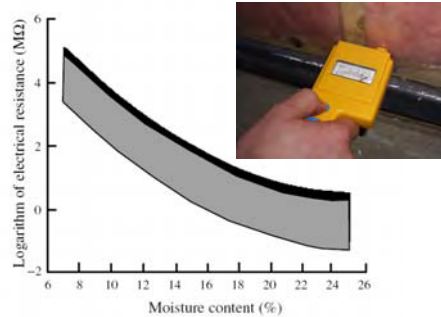
solid masonry

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## Wood MC vs. Resistance

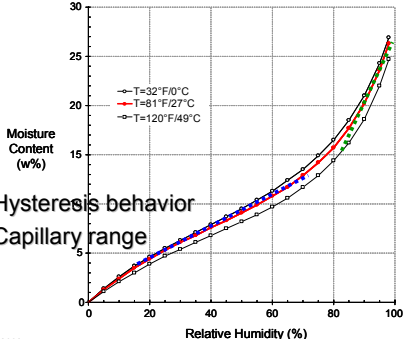


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## Sorption Isotherm



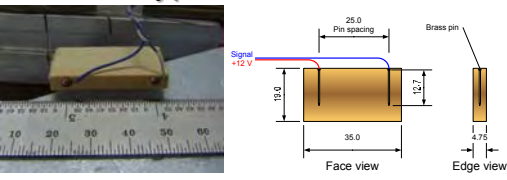
- Hysteresis behavior
- Capillary range

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## Sensor Type: "Wafer"



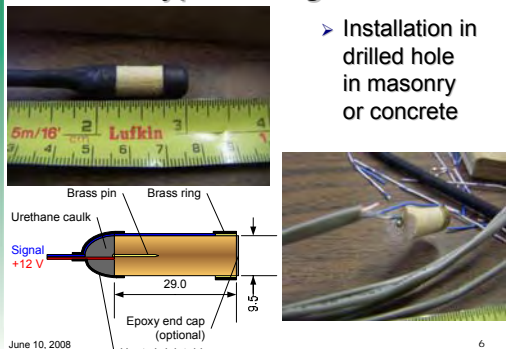
- Installation at planar interface

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## Sensor Type: "Plug"



- Installation in drilled hole in masonry or concrete

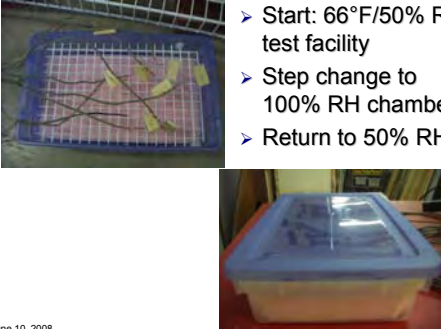
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**bsc** Laboratory Calibration

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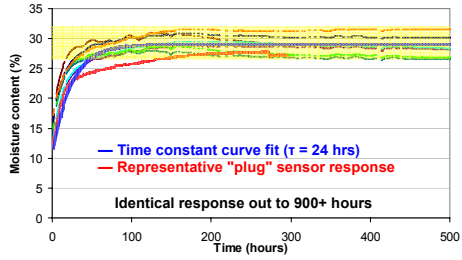
- Start: 66°F/50% RH test facility
- Step change to 100% RH chamber
- Return to 50% RH



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**bsc** Wafer Laboratory Calibration: Adsorption (Wetting)

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Moisture content (%)

Time (hours)

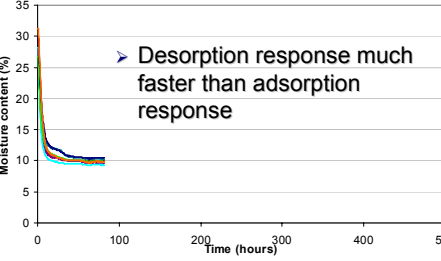
- Time constant curve fit ( $\tau = 24$  hrs)
- Representative "plug" sensor response

Identical response out to 900+ hours

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**bsc** Wafer Laboratory Calibration: Desorption (Drying)

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Moisture content (%)

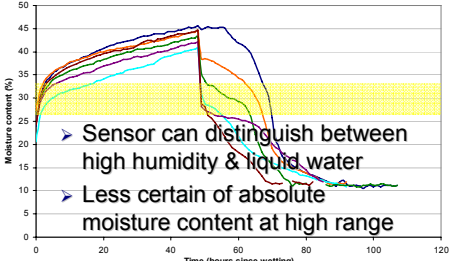
Time (hours)

- Desorption response much faster than adsorption response

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**bsc** Laboratory Calibration: Immersion Testing

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Moisture content (%)

Time (hours since wetting)

- Sensor can distinguish between high humidity & liquid water
- Less certain of absolute moisture content at high range

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**bsc** Resistance vs. Gravimetric Time Response

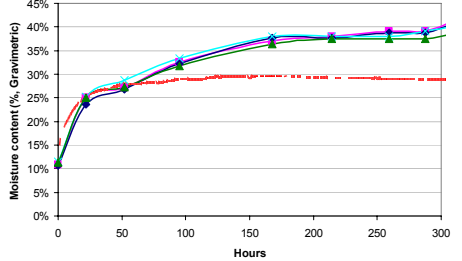
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**bsc** Resistance vs. Gravimetric Time Response

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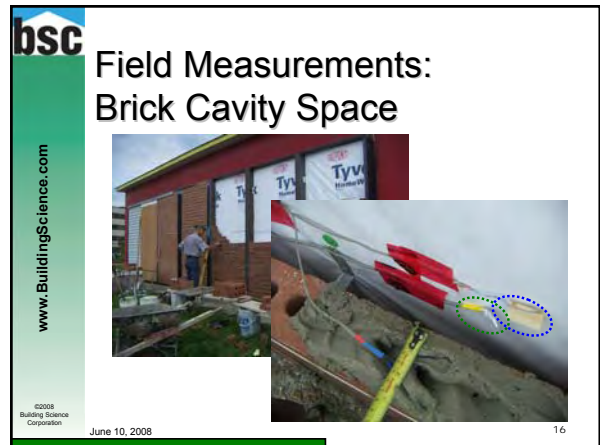
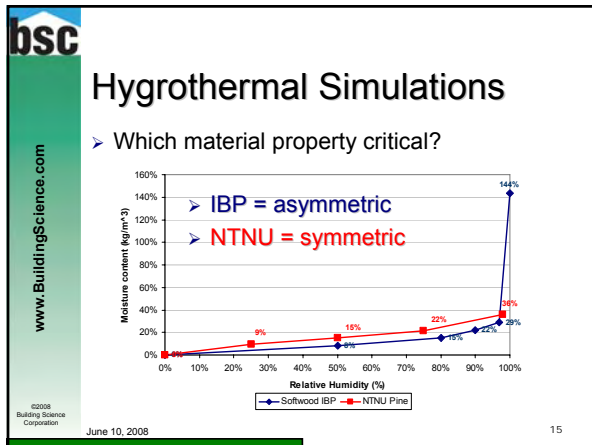
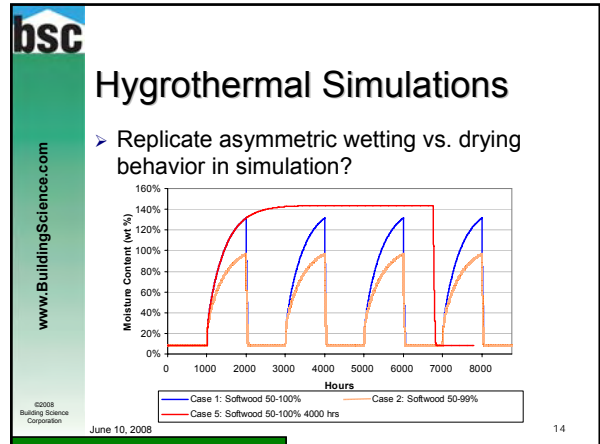
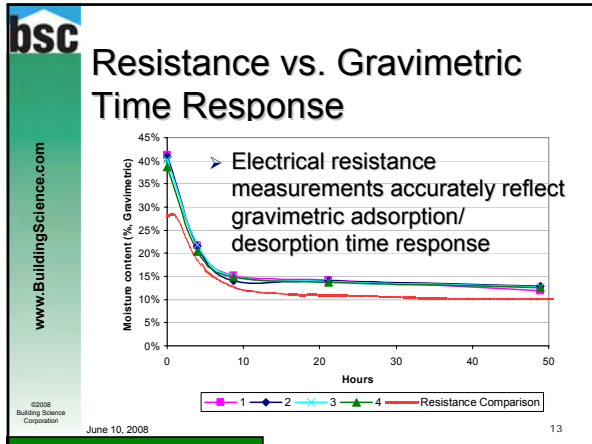


Moisture content (% Gravimetric)

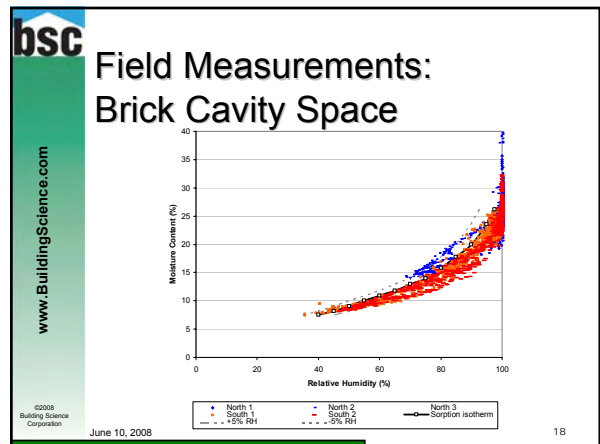
Hours

- 1
- 2
- 3
- 4
- Resistance Comparison

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- ### Field Measurements: Brick Cavity Space
- 90-100% RH from October-May (typical)
  - 40-60% RH summer (South)
  - ~80% RH summer (North)
  - Many RH sensor failures (intermittent data, 4 of 6 survived)
  - Wafer sensors showed similar seasonal pattern
  - Wafer sensors returned consistent data throughout
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**bsc** Field Measurements: Basement Wall Insulation

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**bsc** Field Measurements: Basement Wall Insulation

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**bsc** Field Measurements: Inward Vapor Drive Condensation

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**bsc** Field Measurements: Inward Vapor Drive Condensation

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- ▶ Six walls (3 N/3 S)
- ▶ 1" XPS & 2x4
- ▶ OSB & 2x6 (polyethylene)
- ▶ OSB & 2x6 (no poly)

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**bsc** Field Measurements: Inward Vapor Drive Condensation

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**bsc** Field Measurements: Inward Vapor Drive Condensation

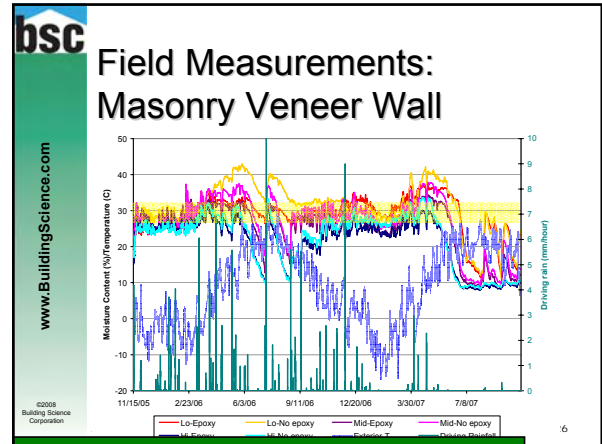
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**bsc** Field Measurements:  
Masonry Veneer Wall

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**bsc** Conclusions

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- 100% RH  $\approx$  27-32% MC
- Liquid water condensation as distinct response vs. 100% RH
- Field installation  $\pm$ 10% RH or better,  $\pm$ 5% RH typical
- Slow wetting response, fast drying
- Use for longer-term (e.g., seasonal) measurements, not diurnal
- Good reliability in field installations

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**bsc** Acknowledgements

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U.S. Department of Energy

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University of Waterloo

Questions & Comments

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