2011 World Materials Summit: Buildings and Lighting Panel Report

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Top points from this committee:

1. Building scientists (which includes systems simulation specialists) must work together with materials scientists in alignment with industrial materials providers and integrators.
2. Basic materials researchers should develop much greater understanding and appreciation for Life Cycle Assessment.
3. Advances are needed in thermal exchange materials and advanced optical materials, but must be constrained by extremely low costs and high performance.

Detailed Reporting:

- **Building systems current technology:** there is a gap between the needs of the building sector (for energy demand and savings/efficiency with equal amenity) and the current focus of materials scientists. In China, the state of the technology is sufficient for major changes in energy efficiency…Enormous potential for the built environment
- **Vision:** *Materials scientist relationships must be strengthened among building scientists, building designers (architects), and the building materials industry, to achieve a 50% reduction in global energy consumptions in buildings by 2030.* [This is also in alignment with AIA 2030 (American Inst. of Architects) and DoE stated goals.]
- **Priority research directions:**
  - Understand location-specific dynamics and location-dependent material demands,
  - Develop better whole systems-scale simulation and optimization tools with easy user interfaces,

- Expand research in phase change materials,
- Develop cost-effective semiconductors for sensors, lighting, communications, power electronics,
- Develop cost-effective materials for integrative sensors, microelectronics, energy harvesting, communications and controls,
- Expand thin film research into meso-scale thickness range (200 nm - 5 micron) and variable porosity (from compact to 50%) for heat exchange fins, ionic exchange membranes, photovoltaic thin films, electrochromic films,
- Increase efficiency of HVAC systems with novel heat exchange, working fluids, innovative dehumidification technologies, making use of low-grade thermal energy,
- Develop materials with controllable and variable surface optical properties to optimize the interface between the building the environment, and
- Develop adaptive vapor retarders (sometimes an impermeable humidity barrier, sometimes allowing moisture vapor permeability)

- **Basic materials researchers should understand the state of the art within industry:** real bottlenecks, challenges to deployment or bridging the valley of death, recognizing IP issues that serve as barriers to collaboration and learning both regionally, nationally, and internationally.
- **Basic materials researchers should develop much greater understanding and appreciation for Life Cycle Assessment.** We recommend developing strengths/skills in Life Cycle Inventory for materials (database generation) and Life Cycle Assessment—both of which are critical to the building industry.
- **Recommendation to increase the dialogue between building designers, building scientist, policy makers, and materials producers/manufacturers around regulations.** [e.g. example of porous cement from the The Inst. of Technical Supervision and Research for the Building Materials Industry]
- **International Cooperation:** Western researchers do not typically have a strong familiarity with the Chinese built environment and social considerations. In order to accelerate mutual understanding, we recommend establishing professional society offices in China to encourage exchange of information. Also consider matching funds

with China to increase research scientist visiting fellowships to China.

- **Major opportunity:** in developing insulation in China, for low-cost flame-retardant, high-performance and long-lasting properties. There is great potential for deployment, with key emphases on applications, processing and reproducibility.
- **Impediments to Intl. Cooperation:** The crucial stumbling blocks in the building industry is in assuming that all buildings exist in that singular country—while building scientists emphasize that climate and cultural norms are important in making materials decisions for highest utility.
- **Impediments to Intl. Cooperation:** Lack of recognition for IP issues is a barrier to collaboration and learning both regionally, nationally, and internationally.
- **Recommend connecting to grid and storage panel priorities.** Building energy control systems must be integrated with the grid for demand response mechanisms. There is long-term work developing for agent-based systems in a building to negotiate for power vs costs/value, and this extension is being explored for the grid as well.
- **Open questions:** Building science has attempted to solve an issue of energy loss through the façade/membrane of the building, but in doing so has created significant new problems/challenges in **Indoor Environmental/Air Quality (IEQ/IAQ).** Materials scientists will likely be called upon to develop materials for systems that remove/filter organic contaminants (VoCs), microorganisms, particulates, and inorganic molecular species from the indoors, *and to develop new building materials* that do not emit a concentrated hazard (e.g. aldehydes, particulates) in the first place.
- **Open opportunities:** Developing building research testbeds in major housing types (most are large, multifamily structures), and factories, and in different climatic areas of China as international collaborations.