Phase Change Materials in Architecture

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Thanks to Professor Mohammed Farid and his team at the University of Auckland
Just a phase?
A discussion of the role of phase change materials in mainstream interior architecture in New Zealand
What?

A phase change materials (PCM) are substances with a high heat of fusion. Exploiting their endothermic and exothermic reactions using the latent heat of fusion means they are capable of storing and releasing large amounts of energy by melting and solidifying at a given temperature. PCMs use the energy stored in chemical bonds. The thermal energy transfer occurs when materials change state, or phase, from liquid to solid, or solid to liquid (Vavan Vuceljic, 2009).
Why?

PCMs have the potential to reduce the energy needed for space heating and cooling whilst improving the quality of the space, in residential and commercial applications. This is because better use can be made of the “free” energy of the sun coming through windows. This will melt the waxes which then solidify once the temperature drops returning the heat to the space when it is most needed. In cooling situations, taking the energy out of the air from solar gain because it is absorbed by the PCMs reduces the cooling load.
Distributed Thermal Storage in Full-Scale Office Buildings Using Phase Change Materials

Khudair, A. Farid, M. Chen, J. Hamadi, N.
Who?

• The first documented use of a PCM as form of passive heating was by Dr Maria Telkes, the “Sun Queen”, in 1948, in Dover, Massachusetts.

• Energain from DuPont is a board material of PCM sandwiched between 2 layers of Aluminium for application behind dry wall board.

• Smartboard from BASF, marketed by Knauf, is a dry-line gypsum based board impregnated with BASF’s Micronal® PCM, of paraffin droplets micro encapsulated in a non-formaldehyde capsule.

• Delta-Cool 24 by Dörken is a packaged PCM suited to retrofit situations, above ceilings, under floors etc.

• Glass X by Peyerbeer is an aluminium framed window element for installation in the facade with the ability to filter solar gain to seasonal requirements based on the angle of the sun.

• Clima 26 by Maxit is a trowel on internal plaster finish in a gypsum base for wall finishing with added thermal insulation.
Maria Telkes

http://web.mit.edu/solardecathlon/history - 09 August 2009
http://www.eoearth.org/article/Telkes,_Maria
Each DuPont™ Energain® panel measures 1.0m x 1.2m. It weighs 5.4kg and can be easily handled and installed by just two people.
Raw Materials:
• as powder or aqueous liquid
• at 21°C/70°F, 23°C/73°F, 26°C/79°F

Construction Materials:
• Micronal® PCM SmartBoard™
• Maxit Clima 26®
• CelBloc Plus – PCM-Aircrete
Knauf SmartBoard™

- Polymer coating
- Wax
  - $F_p$: ca. 26°C
  - $\Delta H$: 110 J/g

5 µm
Realized Buildings with Micronal® PCM (selected examples)

2001
- 3 Liter-Haus in Ludwigshafen
  Foto: LUWOGE, Ludwigshafen

2002
- Büroneubau der Badenova in Offenburg
  Foto: Maxit, Bresbach

2003
- DSC der LUWOGE/Fortisnova, Ludwigshafen
  Foto: LUWOGE, Ludwigshafen

2004
- Hotel- und Bürokomplex in Berlin, Gotzkowskistraße
  Foto: privat

2005
- Haus der Gegenwart in München
  Foto: Haus der Gegenwart, München

2006
- Sonnenschiff Passivhaus Bürokomplex in Freiburg
  Foto: Sonnenschiff.de
- Sodastraße 40 in Ludwigshafen
  Foto: Stadt Lauffen a.N.
- Hölderlin Gymnasium in Lauffen am Neckar
  Foto: Stadt Lauffen a.N.

Massive walls with Aircrete
Thousands m² SmartBoard in dry wall construction
THE 3-LITER-HOUSE –
An innovation in the modernization of old properties

The energetic concept

Controlled ventilation system incl. heat recovery

Heat retaining plaster

NEOPOR® - foam heat insulation

VINIDUR triple-glazed windows

Fuel cell
Summer sun high in the sky (\(> 40^\circ\))
Total reflection of the rays

Shallow winter sun (\(< 35^\circ\))
Loss-free passage of the rays
## THE 3-LITER-HOUSE –
An innovation in the modernization of old properties

<table>
<thead>
<tr>
<th>Modules</th>
<th>Costs</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overhaul</td>
<td>267 €</td>
<td>Refurbishment of the building envelop, electric und sanitary overhaul, balcony and stair case refurbishment</td>
</tr>
<tr>
<td>General Modernization</td>
<td>502 €</td>
<td>Ground plan optimization, bath modernization, central heating installation, enlarging and renewal of windows, renewal of doors and floor covering, large balconies</td>
</tr>
<tr>
<td><strong>Energetic Modernization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>🌞 7-Liter-House*</td>
<td>108 €</td>
<td>Outer wall, roof and basement ceiling insulation = 10 cm, windows U = 1,4 Wm²/K</td>
</tr>
<tr>
<td>☀ 4-Liter-House**</td>
<td>201 €</td>
<td>Outer wall, roof and basement ceiling insulation = 20 cm, windows U = 1,4 Wm²/K, controlled ventilation system with 75% heat recovery (central), minimization of thermal bridges and achievement of air tightness</td>
</tr>
<tr>
<td>☀ 3-Liter-House*</td>
<td>517 €</td>
<td>Outer wall, roof and basement ceiling insulation = 20 cm, windows U = 0,8 Wm²/K, controlled ventilation system with 85% heat recovery (central), extensive measures to minimize thermal bridges and to achieve air tightness</td>
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</tbody>
</table>

* Already carried out ** not yet carried out

Only costs for insulation of building envelop

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Dr. Wolfgang Schubert
LUWOGE – Wohnungsunternehmen der BASF GmbH

25 Sustainable Revitalization of the Brunk Quartier Dr Wolfgang Schubert
Where?
Incentive?