PolyArch – Transferring polymer technology into the field of building technology

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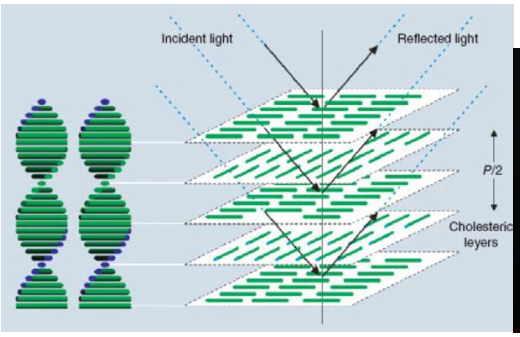
Introduction
The challenge of the future is to minimize the energy consumption of buildings while maintaining an optimal comfort level in the interior. Controlling the energy streams in and out of the building , and especially daylight management, plays an important role. It deals with many, sometimes conflicting functions of the building: Generally a maximum of natural lighting is desired to reduce the need for lighting energy which in today's buildings accounts for approximately 30% of the total electricity demand. But daylight contains a lot of energy. We need to block sun radiation in summer to prevent overheating, whereas in winter this incoming energy is desired to reduce the need for heating energy
There are several traditional strategies to control daylight such as metallic coatings, exterior and interior sunshades. The existing daylight management strategies are rather inefficient or they involve considerable constructive effort, high investment costs and high maintenance and cleaning expenditures. On top of that the architectural impact of additional external or internal functional layers is big and they often do not meet the expectations of designers.

Contributions towards solving the problem
Our collaborating party, the Department of Functional Organic Materials and Devices at the TU/e is a leader in developing new responsive coatings. With these materials we will be able to switch physical properties such as colour, reflectance and heat transfer. For instance, responsive liquid crystal networks may adapt the degree of reflection. The position of the reflection band in the electromagnetic spectrum can be dynamically shifted in response to temperature or light. Reflection can be shifted in the near infrared part of the spectrum thus controlling heat flux without affecting transparency in the visible part of the spectrum. When applied on a glass window this film determines whether the heating part of sun light is being transmitted or reflected.



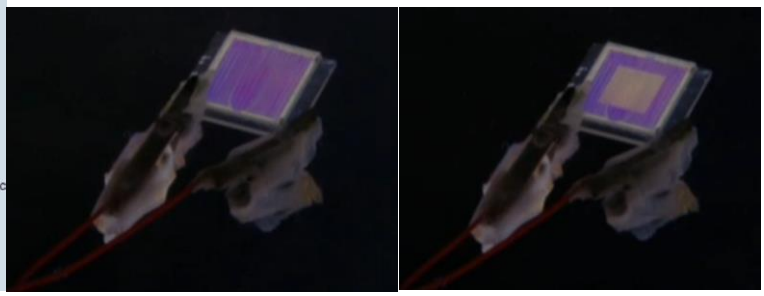


Figure 1: Responsive polymer coatings can reflect daylight in varying wavelength
Figure 2: Small prototype showing the possibility to electronically switch IR transmittance : left "off" / right "on"

Since it is responsive, this technology will potentially deliver a much better performance than current static metallic coatings without the need for additional constructive effort for external sun shading devices. The impact of this new concept on the established building process is low and we can expect a high acceptance by decision making parties. Figure 3 shows the great potential that responsive coatings on the nanoscale have in relation to traditional technologies for daylight management.

Aim of the proposal

Over the past two years we have been discussing with numerous stakeholders the possibility of applying responsive polymer based technology in the field of building. This has been done in several workshops and individual meetings In other disciplines, such as LCD screens and automotive industry similar technologies have been successfully applied.

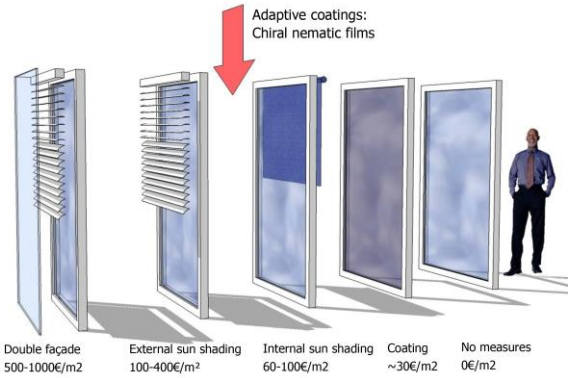


Figure 3: Responsive polymer coatings show a great potential for energy savings in daylight management systems and this potential needs to be verified.
Figure 4: Testing the prototypes in the LightVan

With this proposal we aim at **clarifying the energy savings potential** as well as identifying the technological challenges that need to be tackled in order to **get PolyArch market ready**. Prototypes of the product will be displayed and tested in the LightVan, a mobile light laboratory, see figure 4.
If we can generate a positive and promising outcome with funding of the 3TU Bouw lighthouse proposal, we will be able to **develop proposals for further research (STW, H2020).** As a first step we are focussing on daylight management but responsive polymer coatings also show a great potential for other building related applications such as responsive surfaces to control heat absorption/emission, responsive insulation and colour change of architectural surfaces.

Workpackages

The proposal consists of three work packages:
1. TUD, Department of Architectural Engineering: The definition of applications of responsive polymer coatings and the development of façade concepts.
2. TU/e, Department of the Built Environment : Calculations about the adaptive energetic properties of responsive polymer coated windows. The group has recently developed a new method of calculating adaptive performances.
3. Department of Chemical Engineering TU/e: development and fabrication of samples with chiral nematic responsive polymer coatings. The properties will be defined in collaboration with TU/e and TUD

Financial plan

The 3TU-funding will be mainly used for fabrication of polymer coated sheets (ca. €25.000), façade prototyping and building mockups (ca. € 10.000) and equipment for simulation and measurements (ca. € 10.000).

Project results

- Demonstrate the TU role in innovative technology transfer from chemical engineering into building technology
- Verify the potential of responsive polymer coatings for the field of building technology
- Convince the chemical supply industry to invest in innovation in building technology
- Active advertisement for 3TU Bouw via publications including for example the Journal of Façade Design and Engineering and the Materials Chemistry journals.

Project planning

Manufacturing first prototype(s)	February – June 2015
Setting up the test facility in the LightVan	April – June 2015
Measurements	June –September 2015
Computer simulations	May – September 2015
Analysis of potentials and further developments	September - October 2015
Manufacturing updated prototype(s	November – December 2016
Measurements phase 2	January - February 2016
Seminar with stakeholders including live demo	March – April 2016