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Ultra-Thin, Energy-Efficient Facades – a Contradiction in Terms?

Within the European Union about 40 percent of the energy is consumed in buildings. In Germany roughly a quarter of the primary energy demand is used for the heating of buildings. A detailed analysis reveals that more than 90 percent of this energy can be related to old buildings, which were constructed before 1977. Reducing the heat losses through façades and using transparent or translucent façade elements to profit from solar heat gains are some of the first measures to improve energy efficiency of buildings. With the use of state-of-the-art insulation materials, thermal heat losses via the façade could be sufficiently reduced to provide an excellent insulation standard. However in some cases, lack of space or aesthetic needs, do not allow for sufficiently thick insulation layers.

Within the last decade vacuum insulation panels (VIP) were developed, whose thermal conductivity values are 5 to 10 times lower (e.g. 0.002 to 0.008 W/(m×K) at ambient conditions) than those reported for standard insulation materials [1]. Thus a 2 cm thick VIP could replace a 20 cm of standard insulation material, e.g. polystyrene foam, with no changes to the thermal performance. Nowadays VIPs are commercially available and used more and more for the insulation of buildings, especially if space for insulation is expensive or not sufficiently available or a slim architecture is preferred. Right now an innovative evacuated double glazing (VIG) is being developed which provides an U-value below 0.5 W/(m²×K) for a system thickness of only 9 mm [2]. The low weight of such a glazing reduces the mechanical requirements in comparison to a standard triple glazing [3] and thus allows for the use of thin, highly insulating frames. With these slim opaque and transparent insulation elements (VIP, VIG) ultra-thin and aesthetic façade construction can be realized. However, reducing the construction mass of building walls also leads to a loss of thermal capacity and therefore more regulation measures are needed to keep a comfortable living climate within such a building.

It is expected that in future multifunctional façade elements will further improve the thermal performance of buildings. One example is the switchable insulation, where the thermal conductivity can be electrically switched from 0.002 W/(m×K) to 0.16 W/(m×K) within minutes [4]. Future research work is dedicated to the application of textiles in architecture. Such textiles can be functionalized by using low-e coatings to reduce radiative heat transfer or by adding phase-change-materials (PCM) to enhance the thermal capacity of the textile based, low-weight constructions [5]. The combination of such textiles with vacuum insulation panels to improve the insulation properties or with flexible photovoltaic cells to generate electricity is another key aspect of textile architecture. This research work was supported in the past by the Bavarian Ministry for Economics, Information, Traffic and Technology and is actually supported by the Federal Ministry of Economics and Technology.

References:

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