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Colored solar façades for buildings

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Abstract

Solar energy is a prime way to reach net zero energy buildings. Addressing buildings' energy needs is a priority because buildings are the largest demander of energy (followed by industry then transport). However, harvesting energy from solar farms, implies covering large areas with standard black or blue solar modules, which is generally not well accepted by the stakeholders. If architectural coherence is to be preserved, building envelopes cannot simply be covered with black panels with visible cells and contact bars. Today, panels of different colors are available to integrate solar energy smoothly into the built environment. However, while a choice of colors is good news for architecture, it should not cause excessive energy losses.
The Kromatix panels presented in this paper are covered by glass that combines effects of diffuse surfaces and interference filters. With a minimal loss of efficiency, these panels pave the way to new considerations in solar architecture.

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1. Introduction

The acceptance of solar energy systems as integrated elements of the building's envelope is mainly limited by aesthetic considerations. They are often considered as technical components to be hidden and confined to roof-top applications. Architects require solutions that better integrate solar energy as building element components. One aspect of importance is the color of panels [1].

Multilayered interference filters can produce a colored reflection, hiding the active components, while transmitting the non-reflected radiation entirely to the absorber [2], [3]. This stands in contrast to pigment based coloring, which absorbs radiation and does not withstand degradation over time

When such colored glass replaces the conventional front glass of both PV and thermal solar panels, architectural integration of solar panels into glazed building façades becomes an attractive choice [3].

While a certain amount of freedom in selecting a color would be desirable, the colored appearance should not cause excessive energy losses and angular stability [2], [3]. The challenge lies in finding the best combination of material choice and layer thicknesses [4].

For the panels presented in this paper, a diffusive surface treatment has been applied on the outer surface of colored laminated glazing. The etching treatment has been applied in order to create diffuse light transmittance, which reinforces the masking effect of the colored filter [5] and prevents glare effects, which can be an obstacle for solar energy integration on buildings. The matt treatment replaces the specular reflection, usual with glasses, by a diffuse reflection. The development is presented in this paper.

2. Gloss reduction by satinated front surface

Etching on the outer surface of panels (the one exposed to the sun) provides a diffuse reflection to reinforce the masking effect of the technical parts of the solar device and to prevent glare effects.

Figure 1 b) presents SEM pictures of glass surfaces structured in the EPFL Solar Energy and Building Physics Laboratory. In the first case, the surface is relatively smooth and presents some micro-scale protrusions and furrows arising from the junction of nano-holes which are present on the entire surface. In the second case, the surface features a much rougher structure and is densely covered with a structure resembling pyramids. These pyramids have a height of around 10 µm, are defined by different types of polygons as their base area, whose dimensions are often around 100 µm to 120 µm and who have pronounced nano-structured side walls. The measured gain in solar transmittance can then be explained by anti-reflective properties resulting from micro-scale patterning in combination with a nano-scale roughness modification.

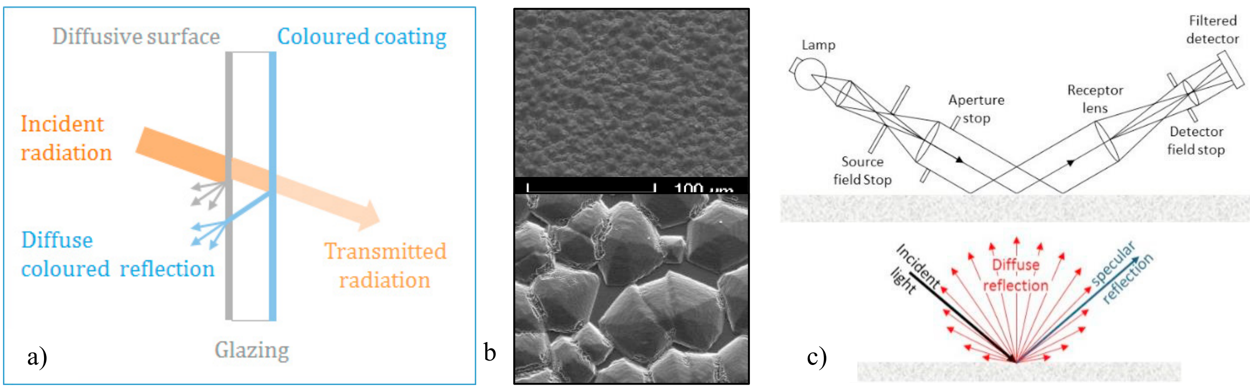

Fig. 1. a) Scheme of the glass with the diffusive surface and the colored coating.
b) SEM pictures of acid etched structures from the Laboratory of the LESO-PB.
c) Scheme of a gloss meter, diffuse vs specular reflection.

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