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# Predicting Electrochromic Smart Window Performance

JOHNNY DEGERMAN ENGFELDT

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**Abstract**

The building sector is one of the largest consumers of energy, where the cooling of buildings accounts for a large portion of the total energy consumption.

Electrochromic (EC) smart windows have a great potential for increasing indoor comfort and saving large amounts of energy for buildings. An EC device can be viewed as a thin-film electrical battery whose charging state is manifested in optical absorption, i.e. the optical absorption increases with increased state-of-charge (SOC) and decreases with decreased state-of-charge. It is the EC technology′s unique ability to control the absorption (transmittance) of solar energy and visible light in windows with small energy effort that can reduce buildings′ cooling needs.

Today, the EC technology is used to produce small windows and car rear-view mirrors, and to reach the construction market it is crucial to be able to produce large area EC devices with satisfactory performance. A challenge with up-scaling is to design the EC device system with a rapid and uniform coloration (charging) and bleaching (discharging). In addition, up-scaling the EC technology is a large economic risk due to its expensive production equipment, thus making the choice of EC material and system extremely critical. Although this is a well-known issue, little work has been done to address and solve these problems.

This thesis introduces a cost-efficient methodology, validated with experimental data, capable of predicting and optimizing EC device systems′ performance in large area applications, such as EC smart windows. This methodology consists of an experimental set-up, experimental procedures and a two-dimensional current distribution model. The experimental set-up, based on camera vision, is used in performing experimental procedures to develop and validate the model and methodology. The two-dimensional current distribution model takes secondary current distribution with charge transfer resistance, ohmic and time-dependent effects into account. Model simulations are done by numerically solving the model′s differential equations using a finite element method. The methodology is validated with large area experiments.

To show the advantage of using a well-functioning current distribution model as a design tool, some EC window size coloration and bleaching predictions are also included. These predictions show that the transparent conductor resistance greatly affects the performance of EC smart windows.


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