GENERAL DESIGN EQUATIONS FOR THE OPTIMIZATION OF COMPLEMENTARY ELECTROCHROMIC DEVICES

Kuo-Chuan Ho, Wei-Lun Chang, and Lin-Chi Chen

Department of Chemical Engineering
National Taiwan University
Taipei,Taiwan 10617

The optical attenuation of complementary electrochromic devices (ECDs) with two reversible electrodes operating in tandem is presented theoretically. The transmittances of electrochromic (EC) thin film electrodes are related to the electrochemical and optical properties of each coated EC layer. By combining the electrochemical and optical properties of these two electrodes, a general variable transmittance function suitable for describing the switching characteristics of complementary ECDs is developed.

Assuming that the device is operated in the range of reversible potentials, the variation of the device's transmittance only does with the charge capacities on both electrodes. From the definition of coloration efficiency, the relationship between the film transmittance and the charge capacity can be derived. Moreover, the film transmittance is related to the film thickness by Lambert's law. Finally, the concept of limiting electrode [1,2] is utilized to derive the design equation for the device.

Fig. 1 is a plot of the transmittances, both at the bleached and the darkened states, as a function of the charge capacity ratio, R. Fig. 2 is the transmittance attenuation as a function of R. It shows that the transmittance attenuation reaches maximum when R is maintained at unity. Furthermore, the value of the optimum transmittance attenuation has to do with the charge capacity of the film. These design curves provide designers with different options to seek suitable parameters for complementary ECDs. Fig. 3. shows the bleached state, the darknened state, and the attenuated transmittances for R=1.0. It can be learned from this plot that the maximum transmittance attenuation is reached when the charge capacities on both electrodes are set at 12 mC/cm^2. The optical performance of a complementary ECD consisting of WO_3/Polyaniline couple [3] is tested to see if the proposed model is valid.

References :
[1] R. D. Rauh and S. F. Cogan, J. Electrochem. Soc., **140**, 378 (1993).
[2] L.-C. Chen and K.-C. Ho, Electrochimica Acta, **46**, 2151 (2001).
[3] K.-C Ho, L.-C Chen, and C.-C. Lee, Proc. of SPIE, **3788**, 120 (1999).

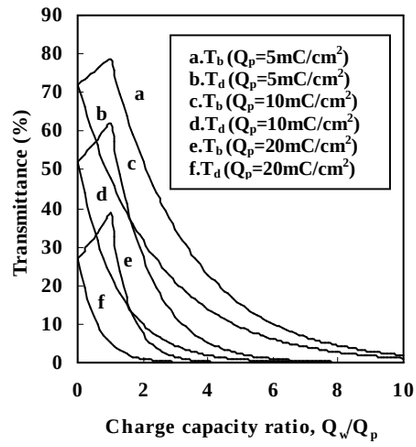

Fig. 1. The bleached and darkened transmittances as a function of charge capacity ratio for various charge capacities.

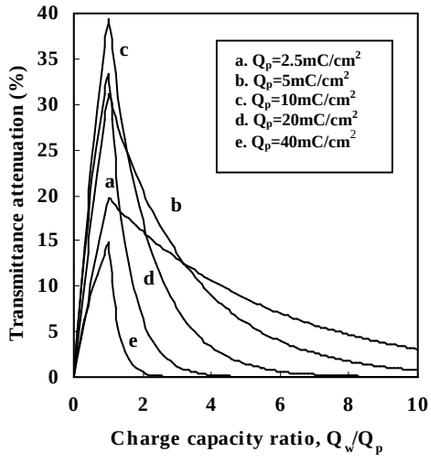

Fig. 2. Transmittance attenuations as a function of charge capacity ratio for various charge capacities.

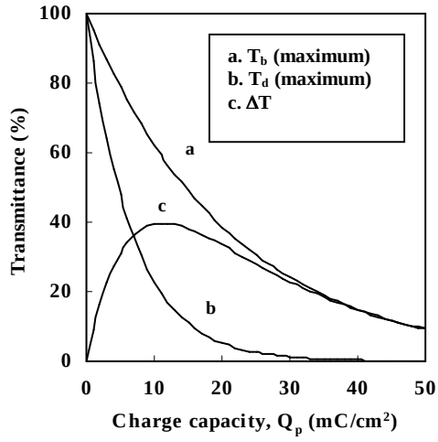

Fig. 3. The optimum design curve at R=1.0.