Image Data Analysis of Electrochromic Display Devices for Improvement of the Durability

([1]*Graduate School of Information Science and Technology*, *Osaka University*, [2]*National Institute for Materials Science*) ○Shifa Sarkar,[1,2] Masayoshi Higuchi[1,2]

Keywords: Electrochromic Devices; Metallo-Supramolecular Polymer; Degradation Analysis; Image Data; Durability

Electrochromic devices (ECDs) are cutting-edge technologies for their applications ranging from smart windows to electronic paper that change optical properties in response to an applied voltage. Among the various electrochromic (EC) materials, metallo-supramolecular polymers (MSPs), specifically Fe(II)-based MSP (polyFe), have received much attention for their unique properties. However, the long-term performance and stability of these devices are critical factors for practical applications. These devices might degrade over time, which would decrease their effectiveness and functionality. It becomes essential to conduct a detailed analysis of the degradation patterns in electrochromic devices to address this problem. This work employs the Python OpenCV library to perform advanced grayscale image processing techniques for the degradation analysis of polyFe-based ECDs.

Here, a solid-state polyFe-based ECD was fabricated by a spray coating method. Then chronoamperometric technique was used to understand the EC properties of the device for each cycle by taking movies and images. The device changed its color from purple to colorless at a low voltage of 1.0V. For the 1st cycle, the images showed a colorless state of the device but in the case 1000th cycle, the device was not able to show a completely bleached state. Besides during the cyclic test, for image data analysis, movies were taken to record the degradation performance phenomenon of the device. Python OpenCV was used to extract images from movies which were then cropped and converted into grayscale images from where pixel values were extracted. By using the pixel values time vs. contrast graphs were plotted for 1st to every 100th cycle till the 1000th cycle. The time vs. contrast graph for the 1st cycle exhibited a sharp change of purple color to a colorless state in the device; on the other hand, the graph for the 1000th cycle didn't show a sharp color change which indicates, the performance of the device becomes slower as the cycle number increases.

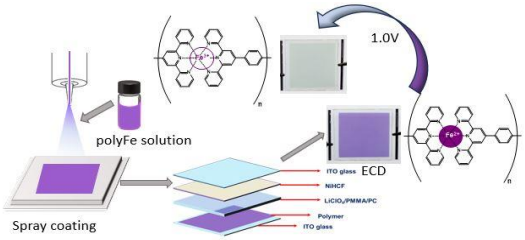

Fig.1: Fabrication and EC properties of a polyFe-based ECD

1) Monk, P. M. S.; ECM and Devices; John Wiley & Sons, **2015**. 2) Gustavsen, A; Sol. Energy Mater. Sol. Cells, **2010**, *94*, 105.

© The Chemical Society of Japan