

# 저구동전압에서 작동하는 새로운 유기 실리콘계 청색 전기발광 고분자 소재 및 소자

## Blue Light-emitting Diodes From Novel Silicon- based Copolymers at Low Operating Voltages

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Electroluminescence (EL) devices based on organic thin layers have attracted much attention because of their wide variety of applications such as flat-panel displays, light-emitting diodes, and lasers. EL polymeric materials offer a number of advantages, such as low operating voltages, three primary R/G/B colors, fast response time, high quality of display, and ease of device processability with semiconductor technologies.

A new class of silicon-based copolymers with a uniform  $\pi$ -conjugated segment were developed (See Fig. 1). Figure 2 shows the UV-visible and PL spectra of silicon-based copolymers. The UV-visible absorbance of present copolymers shows strong absorption bands around 340~360 nm, since the  $\pi$ -conjugated system is regulated by organosilicon units. Their photoluminescence spectra appeared around 460~470 nm in the blue region

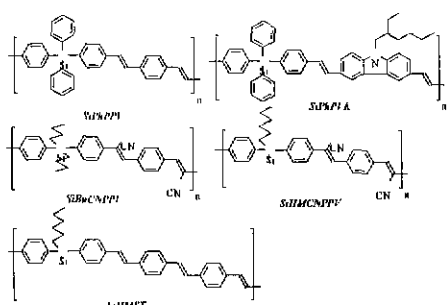


Figure 1. Chemical Structures of silicon-based copolymers

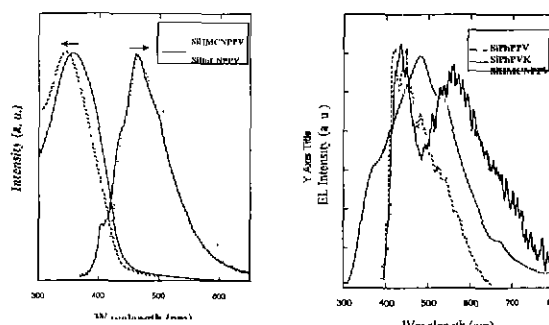


Figure 2. The UV-visible, PL and EL spectra of silicon-based copolymers.

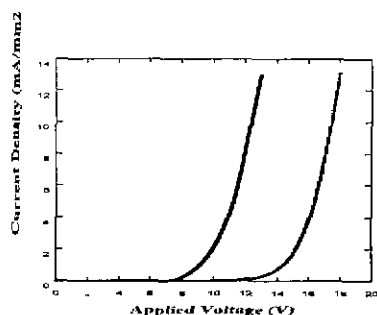


Figure 3. I-V curves of Al/SiHMCNPPV/ITO glass (left), Al/SiPhPVK/ITO (right).

The single layer light-emitting diode of an Al/silicon-based copolymer/ITO glass was fabricated. The forward bias current is obtained when the ITO electrode is positively biased and the Al electrode negatively. The current increases with forward bias voltage and the reverse bias current remains small, which is the typical rectifying characteristics. As shown in Figure 3, the threshold voltage is about 9–12 V for the SiPPV series and 7 V for SiCNPPV series, respectively, which is considerably low compared with the PPV-based block copolymers. Surprisingly, our silicon-based copolymers with a relatively short  $\pi$ -conjugation length exhibit blue light-emitting diodes operated at the voltage of lower than 9 V. It can be explained with our recent results that the lowering of the LUMO level by introducing silicon atoms in luminescent polymers as well as the d-orbital participation of silicon atoms reduces the operating voltages in polymeric light-emitting devices.

The SiBuPPV and the SiPhPPV at the operating voltage of 9 V give a peak in the EL emissive band at 460 nm and 450 nm, respectively, indicating a blue emission (see Figure 2). At the higher operating voltage, no apparent change was observed in the EL spectra. Interestingly, a single-layered light-emitting device of the Al/SiPhPVK/ITO shows both a strong blue emissive band and an additional strong yellow emissive band. The SiPhPVK film shows an EL emissive band at 450 nm at the operating voltage of 10 V. Also, the EL spectrum of the present SiPhPVK polymer shows an additional strong EL emissive band in the yellow range at the operating voltage of 14 V, while the PL spectrum of the SiPhPVK shows an additional strong emissive band in the green range. As a result, the SiPhPVK gives a strong white emissive light at the operating voltage of over 12 V. The single layer light-emitting diode of a Al/SiPhPVK/ITO glass shows the dependence of electroluminescent color on the applied voltage: no luminescence with 0 V, a blue color with 10 V and a white color with 14 V (see Figure 4). In this paper, we will discuss polymeric LED fabrication, EL characteristics, and photophysics for novel silicon-based copolymers.

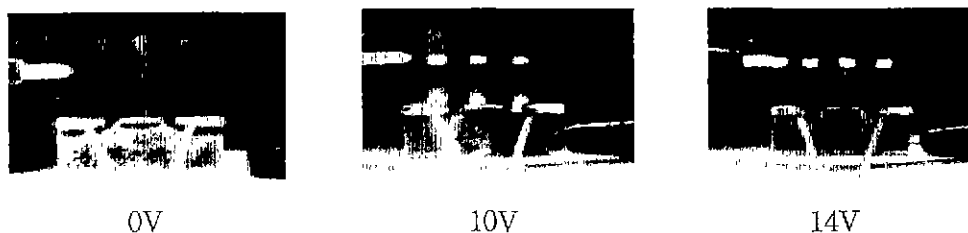


Figure 4. Dependence of electroluminescent color on the applied voltage in the single layer LED of a Al/SiPhPVK/ITO glass: no luminescence with 0 V; blue color with 10 V; white color with 14 V.

#### 참고문헌

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