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Glass strengthening and coloring using PIIID technology

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Every display is equipped with a cover glass to protect the underneath displaying devices from mechanical and environmental impact during its use. The strengthened glass such as Gorilla glass.^{TM} has been exclusively adopted as a cover glass in many displays. Conventionally, the strengthened glass has been manufactured via ion-exchange process in wet salt bath at high temperature of around 500^{o}C for hours of treatment time. During ion-exchange process, Na ions with smaller diameter are substituted with larger-diameter K ions, resulting in high compressive stress in near-surface region and making the treated glass very resistant to scratch or impact during its use.

In this study, PIIID (plasma immersion ion implantation and deposition) technique was used to implant metal ions into the glass surface for strengthening. In addition, due to the plasmonic effect of the implanted metal ions, the metal-ion implanted glass samples got colored. To implant metal ions, plasma immersion ion implantation technique combined with HiPIMS method was adopted. The HiPIMS pulse voltage of up to 1.4 kV was applied to the 3“ magnetron sputtering targets (Cu, Ag, Au, Al). At the same time, the sample stage with glass samples was synchronously pulse-biased via −50 kV high voltage pulse modulator. The frequency and pulse width of 100 Hz and 15 usec, respectively, were used during metal ion implantation. In addition, nitrogen ions were implanted to study the strengthening effect of gas ion implantation.

The mechanical and optical properties of implanted glass samples were investigated using micro-hardness tester and UV-Vis spectrometer. The implanted ion distribution and the chemical states along depth was studied with XPS (X-ray photo-electron spectroscopy). A cross-sectional TEM study was also conducted to investigate the nature of implanted metal ions. The ion-implanted glass samples showed increased hardness of ~1.5 times at short implantation times. However, with increasing the implantation time, the surface hardness was decreased due to the accumulation of implantation damage.

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