NANO SCALE IMPURITY MEASURENENT OF OLED BY ULTRA FAST RAMAN IMAGING MICROSCOPY

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Abstract: Impurity in flexible OLED display films were measured using ultra fastRaman imaging spectroscopy. The flexible OLED display is a relatively thin, multi-layer structure of highly complex materials. The multi-layer film of Polyethyleneterephthalate (PET) and Polyimide (PI) with an adhesive is a key component to be a flexible structure replacing a rigid glass substrate. Nanoscale organic impurity is very challenge to measure due to size of sample. In this study, a confocal Line Imaging Raman microscope operated at 532-nm, max power of 500-mW with 400 x 1340 pixels TE cooled CCD. Sample area of 80 um x 80 um can be measured with 100 x magnification lens, 1 sec integration time at a 200 nm pixels resolution by line Imaging technology within 5 min. Impurity at the surface as well as inside of films can also measure without pick up the impurity by FIB using confocal technology. Most dominant impurity are carbon and glue which might originated from adhesive between two polymer films.

Keywords: flexible OLED, Raman imaging microscope, Polyimide, organic impurity, nanoscale, Thermal damage

I. INTRODUCTION

Flexible IT devices that can be folded or bent are expected to provide convenience to consumers by enhancing portability and space utilization. Transparent polyimide film is the core material of the foldable and flexible displays, and can replace glass materials such as smart phones. The TFT backplane and the organic luminescent layer are formed on the substrate, and then the product is separated from the carrier glass by the laser lift off method.[1] In the POLED produced through these processes, product defects occur due to various foreign substances. Detecting these defects and identifying their causes is a very important process for improving the yield of products. In this study, Raman microscopy was applied to detect various failures in PI film process of OLED. Most recent polymer material for flexible are PI (Polyimide), PC (Polycarbonate), PES (Polyethersulfone), PET (Polyethyleneterephthalate), PEN (Polyethylenenaphthalate), PAR (Polyarylate) and FPR (Glass Fiber Reinforced Plastic)(1). Apart from their high temperature stability up to 400 oC, polymides exhibit high flexibility. To investigate the degradation of PI, both physical properties like tensile strength, adhesion, brittleness and color [2] and chemical changes during polymer degradation are crosslinking or chain breaking, alteration of auto fluorescence, "yellowing" or bleaching caused by the formation of new functional groups. [3,4] optical measurements. Luminescence techniques, one of the most sensitive spectroscopic methods are the method of choice. [5,6]In this study, Ultra fast Raman microscopy was applied to detect various failures in PI film process of OLED. The most frequently occurring foreign substances are organic and inorganic substances due to contamination during the process Foreign material on the surface of film can be easily detected as well as inside of film by confocal microscopy.

II. DETAILS EXPERIMENTAL

2.1. Materials and Procedures

Compressive loads and more frequent thermal shock The PET and polyimide film was supplied by Kolon technology (Seoul, Korea). Raman measurement were performed with a Nanophoton Co (Osaka, Japan) RAMANforce with 532 nm Nd:YAG laser (max power 500 mW) with 1340 x 400 pixel TE cooled CCD detector (Princeton Co. ltd) All spectra were collected with an accumulation with a resolution of 4 cm-1, Optical image was collected by . All Raman spectra were measured with a Raman View ® software in the range of 100 ㅊ - 4000

III. RESULTS AND DISCUSSION

3.1. Identification of Impurity at the Surface of PET Film

The foreign contamination on the surface of the film are inspected using an optical method, and then the defect is identified by various analytical method such as SIMS, TEM, SEM, XRF, FT-IR and Raman microscope. Among these analytical method, Raman microscope is very powerful to identify the impurity withoutdestroying and contact the sample. Figure 1 shows the results of the measurement of foreign contamination on a film consisting of three layers of PET (40*u*m), glue (20*u*m), PET (15*u*m). After identification of the foreign impurity by vision image, Raman spectra was obtained using 532-nm laser with 0.66-mW power at the film surface (A) and the black foreign object (B), respectively. Figure 1 (A) shows the characteristic peaks 1725 cm^{-1}, 1613 cm^{-1} and 1289 cm^{-1} of PET as a reference for PET. In Figure 1 (B), not only PET peaks but also very strong Raman peaks at 3000 cm^{-1}were measured. This is because the

laser beam was measured the foreign impurity together with PET film. The size of impurity was found as less than 5 *u*m x 5 *u*m adhesive.

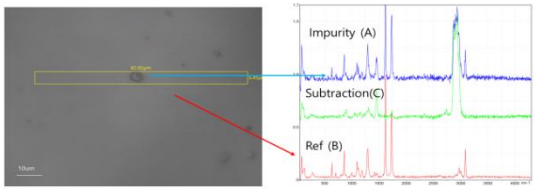


Figure 1. The optical microscope image and Raman spectra of impurity on the PET film; (A) Impurity (B) PET film (C) after subtraction from A to B

3.2. Identification of Impurity below the Surface of PET Film by confocal Raman microscope

Figure 2 shows the Raman spectrum of another type of foreign impurity in PI film. Figure 2A shows the impurity identified as Si which might from SiO_2 impurity remain when the PI layer is separated from the glass substrate by laser. Figure 2B shows the Raman spectrum of a black impurity but similar Raman spectrum as PI. The change in Raman peaks was not measured, but the background line due to photoluminescence was significantly increased compared to the normal region. This change in photoluminescence is due to the physical change of the PI by laser heating.

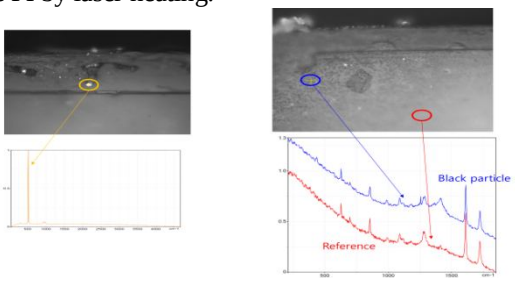


Figure 2. Impurity due to Si (A) and thermal damage of PI film

CONCLUSIONS

Raman Imaging spectroscopy and Photoluminescence was applied to measure the HAZ and impurity at the surface as well as inside of multi-layer films for flexible OLED display. Adhesive impurity less than 5 um at the surface of PET film was also successfully measured. Various impurities identified in the sample were air bubble, Si particle and PI particle due to thermal change. HAZ can be measure quantitatively by measuring the total PL intensity in PI film since PL intensity increases as thermal effect on PI film by laser cutting increase.

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