Hybrid polymers as thermally stable, transparent dielectric material for display applications

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Recent innovations in the field of displays deal with the realization of flexible applications. Major challenges dealing with the realization of high performance flexible displays are the implementation of flexible TFT backplanes and thus flexible functional layers, such as gate insulator and passivation insulator layers (Fig. 1).

Fig. 1. Flexible polymer substrate with ORMOCER® thin film transistors.

This contribution deals with the development of novel insulator materials for flexible backplanes. Independently of their final application within the flexible display, these materials will all have to meet essential properties such as low processing temperatures/high thermal stability, low variation in leakage current density, low hysteresis and low threshold voltage variations. In addition passivation materials need to have a low dielectric constant whereas gate dielectrics have to feature a high dielectric constant. In this context, hybrid inorganic-organic polymers (ORMOCER®s[1]) are a promising class of materials. ORMOCER®s are built up by organically functionalized element alkoxides. Under highly-controlled reactions, continuous hydrolysis and condensation of these precursors take place leading to an inorganic network. Afterwards the hybrid resin can be cured via the organic functional groups. Due to the broad spectrum of possible organic and inorganic functional groups of the precursors, a huge variety of the final properties can be achieved und tuned. Further advantages of ORMOCER®s are in general high thermal and chemical stability and the merger of glassy and polymeric properties within one material. Among others, typical usages of ORMOCER® coatings are dielectric thin-films for electronic and optical applications [2].

For the realization of high performance flexible displays, ORMOCER®s are developed for flexible TFT backplanes to realize innovative gate dielectrics and passivation materials. As a result, the permittivity of the materials was varied between 2.6 and 4.5 by exchanging functional groups of the precursors for example. In this way the ORMOCER® materials were adapted to future applications as either passivation or gate dielectric. The thermal stability of the new materials was demonstrated until ca. 400 °C without showing signs of degradation such as crack formation. Furthermore, the stability of the electrical properties under thermal stress or bending was investigated. The permittivity remained constant until a thermal stress of 300 - 400°C depending on the material. The bending robustness was examined by applying ≥1000 bending events (radius: 30 mm) and subsequent analysis of the electrical properties and showed no signs of degradation even after ca. 20 000 repetitions.

Acknowledgment

The financial support by Korea University Research and Business Foundation [Joint development of highly flexible materials & processes for more than 10,000 times bendable TFT array, with application to flexible display] is highly acknowleged.

References

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