Hybrid polymer as key enabling materials for flexible and stretchable displays

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Inorganic-organichybrid polymers are a versatile material class. Tailored hybrid polymers can beused for different applications in display technology. This contributionprovides an overview about characteristics of hybrid polymers and describesdifferent applications in this field.

Hybridpolymers (ORMOCER®s) are resins synthesized by a modified sol-gel reaction ofalcoxysilanes. The hybrid approach is realized on a molecular level by use ofalcoxysilane precursors. During the sol-gel reaction, a Si-O-Si backbone is formedwhich is organically modified. When reactive groups are used as organicmodification, the material can be designed as photo-definable material whichcan be directly patterned inlithographic processes without any etching step. The cross-linked material, therefore, comprisesa two-fold network: an inorganic and an organic one.

Dueto the Si-O-Si backbone the cross-linked material is basically featured byproperties similar to SiO_2 layers. This results in excellent opticaland dielectric properties. The degree of inorganic cross-linking predominantlydetermines the mechanical properties. In consequence, the material propertiescan be shifted from soft materials which behave similar to silicones to veryhard layers which can be used for, such as e.g., anti-abrasion coatings. TheYoung's Modulus can be adjusted from a few MPa to > 3 GPa.

Bymeans of organic functionalization dielectric properties can be adapted, suchas refractive index and permittivity. Refractive indices can be tuned from 1.47to 1.60, and the regime can further be extended by addition of nanoparticles. Thedielectric permittivity of ORMOCER®s can be tuned from 2.5 to 5.5. When used asinsulator, the materials show a low leakage current (< $1*10^{-9}$A/cm2) and high dielectric strengths (> 400 V/µm). Taking the propertiesmentioned above into account, a number of applications can be addressed in thefield of display technology, such as specially designed substrates forflexible/stretchable displays, encapsulation and passivation layers, gatedielectrics or interlayer dielectrics. By further addition of particles andfibers, new materials can be generated such as high-k dielectrics, transparentconductors or scattering layers for backlight applications. The incorporation of quantum dots into the opticalORMOCER® matrix is feasible, as well.

Notonly the properties can be tuned but also the processing schemes. The ORMOCER®resin can be formulated for different processing techniques, such as ink-jetprinting or screen-printing, but also for conventional spin-coating anddip-coating processes.

Dueto the twofold cross-linking an extremely low amount of monomers is present inthe material, and the thermal stability is excellent compared to most purelyorganic polymers. Therefore, the material can be used in subsequent vacuumprocesses as well as in process techniques and applications which demand formaterials with a high thermal stability.