Sol-gel derived functional layers: impact on the film surface and bulk morphology

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Sol-gel derived materials have the potential to provide cost efficiency to obtain films with additional embedding functionality, and recently have attracted considerable attention in LED applications. Several authors considered the sol gel derived materials as high performance encapsulant for light emitting diodes [1-3]. Typical encapsulant materials, which are nowadays used in LED applications, are based on polymeric matrix (mainly silicones) with which the cavities that contain one or several chips are filled. Various deposition techniques have been developed over time, all being based on comparable material systems. However, as the temperature and optical requirements increase, the use of such organic containing materials becomes limiting in the devices performance resulting in formation of the cracks and/or yellowing within the encapsulant. On the other hand, purely inorganic sol-gel films often have an upper critical film thickness which hinders their implementation in the mentioned applications. In this work, we have investigated the sol-gel derived materials as a new and innovative solution for next generation LEDs. Special aspect on the adhesion properties of such materials to the substrate, same as on the film quality is provided. Use of the sol gel derived matrix as encapsulant material with model oxide particles in two grain sizes and several levels of load (0-70%) within the matrix is tested. In the investigation of both, surface and bulk morphology of the films, the specific impact of the particle load and fabrication conditions (processing temperature) on the adhesion of the formed layers is given. Our preliminary results have indicated formation of cracks in the sol-gel matrix for fabrication temperatures higher than 150°C. However, there was no evident difference in the formation of cracks for the different loads, except that the 70% load resulted into a rather airy film where the cracks may effectively relax. An important factor - the penetration depth for the cracks – has been investigated via cross-sectional view inspection and will be discussed.

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1. Kim et al. Chem. Mater., 2010, 22 (11), 3549-3555
2. Kim et al. J. Mater. Chem., 2012, 22, 7954-7960
3. Kim et al. ACS Appl. Mater. Interfaces, 2014, 6 (5), 3