Abstract

The sol-gel method, which is used during production of hybrid materials in a form of thin films and bulk xerogels, gives the opportunity to obtain luminescent materials of high quality optical and structural properties. In this thesis, I developed the procedure of obtaining thin films of TiO_2, ZrO_2 and ZrO_2/SiO_2 and bulk xerogels of titanium dioxide. We obtained structural characteristics of such matrixes using XRD, Raman spectroscopy, AFM, and ellipsometry.

The inorganic matrices obtained using our methods are high quality porous material with the possibility of transformation from an amorphous to nanocrystals form. In one step of sol-gel process we embedded organic dyes into the porous structure of inorganic matrices to produce the luminescent hybrid material.

In the next part of this thesis I examined spectroscopic properties of our luminescent material. Using steady-state and time-resolved spectroscopy it has been shown that fluorescent aggregates are formed when the concentration of the dye is high enough. With this in mind, we focused on the possibility of having a control on the aggregation process by modifying the matrix, changing the procedure of its obtaining, and on the structure and photo-physical structure of the dye.

Moreover, we considered the influence of the gelation time of on the material properties. Our results show that the aggregation process depends strongly on the gelation time. Since this property is usually neglected in the scientific publications, the direct comparison of our results with those obtained by other groups may be cumbersome.

The structural and spectroscopic characterization of the hybrid luminescent materials which is included in this thesis, shows that the aggregation of the dye in TiO_2 and ZrO_2 matrix is much weaker than in the SiO_2 case. This fact is very interesting from the point of view of

possible application of those matrices in optoelectronic, where the control of the aggregation process is crucial.

Another interesting fact is that the distribution of dye in the hybrid matrices is not uniform. The concentration of the dye increases locally in the cavities of the porous structure. This results in changes in spectral properties that can be measured using steady-state and time-resolved spectroscopy. Due to locally increased concentration of the dye in cavities, both aggregation and energy trapping are more effective. Hence, the measurement of the fluorescence decay in the presence and absence of energy transfer between monomers and aggregates may be an useful tool of assessing the local concentration. This method may be especially effective when experimental data are compared with the Monte-Carlo simulations. This work describes preliminary results in this field.