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Perspectives On The Future Developments of Nano Scintillators

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The spatial resolution of an indirect x-ray imaging detector is degraded by the light spreading phenomenon in scintillation layer. One way to improve the spatial resolution of these x-ray imaging systems with a thicker x-ray converter is preventing optical crosstalk between neighboring pixels by using segmented scintillators with optically isolated structures, which has applications in mammography, dental imaging, and micro-CT (computed tomography). By using microstructured scintillator layers in the form of thin and long ordered and densely packed needles of scintillator materials coupled to position-sensitive detectors, a higher spatial resolution can be achieved.
By using a new architecture based on the ZnO nanostructures proposed by our group at Amirkabir University of technology [1-3] a better spatial resolution in comparison to traditional imagers can be achieved. In the proposed imager, because of higher refractive index of the ZnO nanowires compared to their walls, each nanowire acts as a light guide (optical fiber) that prevents the generated optical photons to spread inside the imager. One of the advantages of ZnO nanowire scintillator is the simplicity of synthesized by template-assisted one-step electrodeposition technique. The results for ordered ZnO nanowire arrays in porous AAO template show that for 10 keV X-ray photons, by suitable selection of detector thickness and pore diameter, the spatial resolution less than one micrometer and detection efficiency of 66% are accessible.
The simulation results also show that the conical frustum nanowires has better spatial resolution in comparison to cylindrical ones. The experimental light yield of ZnO nano scintillator is around 60% of the light yield of single crystal zinc oxide scintillator, which can be improved by suitable annealing or doping. According to the XRD results, the nanowires have a polycrystalline nature with a particle size around 20 nm. Concerning the scintillation spectrum, small but densely packed grains show dominant luminescence from the band gap transition in the UV and only minor contributions from defects. So, the X-ray excited optical luminescence (XEOL) of ZnO deposited by electrodeposition is due to band gap transition and has a peak at 390 nm.
In conclusion, better spatial resolution of this nano scintillator in comparison to bulk ones and the possibility of optimization its detection efficiency by increasing the porosity of the membrane and also it's thickness, are the advantages which candidate this nano scintillator for medical imaging or even high energy physics tracking in the future.

References

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