Chapter 7

Summary and scope of the future work

7.1 INTRODUCTION

The properties exhibited by nanoparticles in their bulk form are distinctly different. This is one of the primary reasons for which these particles are subject of extensive research and study at present. The focus of most of these studies is to explore the potential of nanoparticles in their use as such and in various applications. Both nanoparticles and nano cluster materials show interestingly unique chemical and physical properties which are markedly different from their behaviour in the bulk form.

7.2 Summary

The nanocrystalline, $GdAlO_3$ is readily synthesized by a simple, low temperature process that is self-propagating. Solution combustion method is characterized by a rapid, almost instantaneous, one-step, energy saving procedure. The corresponding metal nitrates constitute the oxidizers while ODH is used a fuel. The preparation requires only a few minutes. The synthesis temperature required is much lower than those currently used in conventional approaches. This technique enables achieving phase purity and homogeneity of GAP at temperatures at around 1000 ºC, which is significantly lower than the 1300 ºC and above required in case of solid state method.

The main objectives of this research focused on development of phosphors for near UV excited white light generation Red-emitting $GdAlO_3:Eu^{3+}$,white-emitting $GdAlO_3:Dy^{3+}$and green-emitting $GdAlO_3:Tb^{3+}$ are found to be highly efficient, high quantum efficiency phosphors for white light generation in terms of strong absorption and good excitation profile . The transition metal ions doped GAP is used to check the possible application of the phosphor in conductivity and supercapacitor applications.

The PXRD pattern showed the presence of alpha phase, orthorhombic structure and the particle size is observed in the nano scale. The pattern was compared with JCPDS File No. 46- 0395. The PXRD intensity decreases, with dopent concentration indicates that dopant ions are strongly capped in to the crystal lattice of $GdAlO_3$. The quality of the refined data was checked by measuring GOF (goodness of fit) found good fitting with experimental and theoretical plots. FTIR spectra of as prepared and heat treated samples shows characteristic peaks around strong bands at 453 cm^{-1} and 683 cm^{-1} could be attributed to the metal–oxygen (Gd–O or Al–O) stretching vibrations which are characteristic vibrations of perovskite structure compounds. The SEM results reveal that the powder is porous and agglomerated with poly crystalline nano particles. It is observed that on heating GAP powder undergoes swelling and becoming more and more porous. The pores and voids can be attributed to the large amount of gases escaping out of the reaction mixture during combustion. TEM result shows that crystalline nature irregular shaped, highly dispersed and polycrystalline behaviour of the nanoparticles.

A strong band at 250 nm was observed in the DR spectra of $GdAlO_3:Eu^{3+}$, is due to charge transfer from O^{2-} to Eu^{3+}, where as in $GdAlO_3:Dy^{3+}$ the absorption peaks observed at 274 and 325 nm due Gd^{3+} , 350 nm absorption is due Dy^{3+} The energy gap of $GdAlO_3$ doped with Eu^{3+}, Dy^{3+} ,$Tb^{3+}$and CO^{2+} is found to be between 4.6 eV to 5.9 eV . The variation in energy gap is due to doping concentration.

The sharp emission peaks at 591, 612 and 694 nm in $GdAlO_3:Eu^{3+}$ sample can be attributed to the transitions $^5D_0 \rightarrow {}^7F_1$, $^5D_0 \rightarrow {}^7F_2$, and $^5D_0 \rightarrow {}^7F_4$ of Eu^{3+} ions, the concentration quenching of Eu^{3+} emission was due to the dipole–dipole interaction in $GdAlO_3$ host. $GdAlO_3:Dy^{3+}$ nanocrystalline phosphor shows different emission centered at 480, 572 and 670 consist of Dy^{3+} transition $^4F_{9/2} \rightarrow {}^6H_{15/2}$ (blue), $^4F_{9/2} \rightarrow {}^6H_{13/2}$ (yellow) and $^4F_{9/2} \rightarrow {}^6H_{11/2}$ (red) respectively, Multipolar interaction was responsible for energy transfer. The CIE coordinates of $GdAlO_3:Dy^{3+}$ samples falls in white region of the spectrum which indicates the samples exhibit white light emission. Series of sharp emission peaks located around 468, 491, 514, 543, 585 and 620 nm in PL emission spectra, were assigned to the $^5D_3 \rightarrow {}^7F_5$, $^5D_3 \rightarrow {}^7F_4$, $^5D_4 \rightarrow {}^7F_6$, $^5D_4 \rightarrow {}^7F_5$, $^5D_4 \rightarrow {}^7F_4$ and $^5D_4 \rightarrow {}^7F_3$ transitions of $GdAlO_3:Tb^{3+}$. The color coordinates of the $GdAlO_3$: Tb^{3+} phosphors were very close to that of the commercial green-emitting phosphors. The capacitance of $GdAlO_3:Eu^{3+}$, Co^{2+} was increased due to the conductive behaviour of $GdAlO_3:Eu^{3+}$,Co^{2+} and double layer formation on the electrode. The reversibility of the electrode reaction was measured which showing more reversible was the electrode reaction. EIS results show that, $GdAlO_3:Eu^{3+}$, Co^{2+} modified electrode exhibits rapid electron transfer because of the existence of highly conductive. All the studies confirms that doped GAP can be a potential candidate for WLEDs, solid state displays ,forensic science and for super capacitor application.

7.3 Scope of the future Work

Having completed the project and meticulously processed the collected data in the course of the work, it can be concluded that this field of inquiry holds immense potential for further exploration and discoveries. The area is open to be investigated by innovative ideas and routes for analytical details, which can reveal the results obtained from research studies in a new light. For future exploitation of the potential of nanoparticles, this project holds scope for being taken forward, knitted tighter, brought closer to operational requirements, and the results interpreted with a higher level of validation. In exploring the luminescent spectra of some of the main phosphors, the study would have been better equipped if there were more allowance for a baseline with regard to the coating experiments. This would have facilitated exhaustive analysis of the luminescent properties of phosphors before and after the coating process and consequently, enabled sharper focus on identifying which phosphors would be the best test subjects for continued trials. White LED solid-state lighting technology is currently an area that is subject to immense study because phosphor materials act as key components in the fabrication of white LED devices, which are gaining extensive acceptance. The LED parameters such as luminous efficiency and CCT, which endow these materials with the much sought-after properties, are strongly dependent on the physical properties of the selected phosphors. In this thesis, we have exposed the structure and explained the versatile properties of phosphor host materials from the perspective of their practical application in display devices, forensic sciences, and super capacitors.

The fascinating results on the modification of GAP nanophosphors may be obtained if the studies are carried out further with different synthesis method, effect of co-dopant on host, Thermoluminescence, Electron spin resonance, Photo acoustic studies etc.