In the modern agriculture, various agrochemicals such as pesticides, herbicides, and plant growth regulators are widely used for effective pest management and ensuring optimum crop yield. Most herbicide formulations deliver the bulk of the active agents that can be readily released to the environment. This phenomenon leads to pesticide residues in the food chain, and this, in turn, has adverse effects in humans including carcinogenic, mutagenic, and teratogenic effects. As a solution for this, we developed a controlled release agrochemical in which the herbicide is embedded into a matrix that can be released in a controlled condition manner. This study aimed at the synthesis of a new controlled release of herbicides, namely 2-methyl-4-chlorophenoxy acetates (MCPA), 2,4,5-trichlorophenoxybutyrate (TBA) and 3,4-dichlorophenoxy acetates (3,4D) through intercalation of the herbicides into zinc-aluminium-layered double hydroxide by self-assembly and anion-exchange method. The release of herbicides into various aqueous media and the kinetic profile were also studied after the successful intercalation of the herbicides at their optimum condition. In this study, a phase pure, well-ordered nanocomposite was successfully synthesized using both self-assembly and anion-exchange method. Upon the successful intercalation of all the three herbicides into LDH by self-assembly method, the expansion of basal spacing from 8.9 Å in the Zn-Al layered double hydroxide to 19.0, 28.2 and 18.7 Å in zinc-aluminium-LDH-2-methyl-4-chlorophenoxy acetates (ZAM), zinc-aluminium-LDH-2,4,5-trichlorophenoxybutyrate (ZAT) and zinc-aluminium-LDH-3,4-dichlorophenoxy acetates (ZAD) nanocomposites could be observed, respectively. The basal spacing for the nanocomposites obtained by the anion exchange method was found to be 19.0, 23.3 and 19.0 Å for ZAM, ZAT and ZAD, respectively. All the nanocomposites synthesized in this work are of Type IV which is mesoporous type of material containing 48.0 % (w/w%), 54.5 % (w/w%) and 53.5 % (w/w%) of 2-methyl-4-chlorophenoxy acetates, 2,4,5-trichlorophenoxybutyrate and 3,4-dichlorophenoxy acetates, respectively. Release of all anions into various aqueous solutions containing phosphate, sulphate and nitrate anion increased with contact time in the order of phosphate > sulphate > nitrate. This work suggests that the affinity of incoming anion towards the LDHs layer was determine by the charge density of the incoming anion. The release profiles of the three anions into the aqueous solution were found to follow the pseudo-second order kinetic model. This study shows that the zinc-aluminium-layered double hydroxide can be used as a host for controlled release formulation of agrochemicals. Besides single intercalation, the dual intercalation of MCPA and 3,4D (ZAMDX), MCPA and TBA (ZAMTX) as well as TBA and 3,4D (ZADTX) were attempted with Zn-Al-LDH host. All the dual intercalation was synthesized using 0.1 M solution of herbicides. The well-ordered, layered nanohybrid basal spacing was expanded from 8.9 Å in LDH to 19.3 Å for ZAMDX, 23.1 Å for ZAMTX and 20.0 Å for ZADTX, respectively. The release of both anions from the nanohybrids (ZAMDX, ZAMTX and ZADTX) into an aqueous solution of NaSO4 was found to be governed by pseudo second-order kinetics.

This thesis focuses on the preparation and characterization of liquid electrolytes (LEs), polymer gel electrolytes (PGEs) and nanocomposite polymer gel electrolytes (NCPGEs). In this work, lithium bis(oxalato) borate (LiBOB) salt was incorporated as the source of charge carriers. LEs were first prepared by dissolving LiBOB in the solvent, γ-butyrolactone using various molar concentrations of LiBOB. The optimum conductivity (0.8 M LiBOB) of the liquid electrolyte was then gelled with different concentrations of cellulose acetate (CA) to form PGEs. The ionic conductivity of all electrolyte samples were calculated using the bulk resistance value obtained from the complex impedance plot in the frequency range between 100 Hz to 1 MHz. The ionic conductivity pattern of PGEs slightly increases at low cellulose acetate concentration and starts declining with increasing cellulose acetate content. The conductivity reaches a maximum value of 7.05 mS cm⁻¹ for the electrolyte containing 2.4 wt.% CA at room temperature. This phenomenon is best clarified by the Breathing Polymeric Chain model. Although PGE has a high conductivity, its physical properties and dimensional stability need to be improved for practical application. Therefore, the highest conductivity of PGE was dispersed with different weight ratios of nanosized silica to obtain NCPGEs. The highest conductivity of 6.49 mS cm⁻¹ is obtained with the addition of 2.5 wt.% SiO2. Ionic conductivity for all systems was also studied as a function of temperature from 303 K up to 363 K. The plot of log ν versus 1000/T for each sample obeys Arrhenius rule implying the ionic conductivity to be thermally assisted. The conduction mechanism in liquid electrolyte, polymer gel electrolyte and nanocomposite polymer gel electrolyte can be best explained using the small polaron hopping (SPH) model since the power law exponent s increases with the increase in temperature. Transference number characterization supports the ionic conductivity results. The voltammogram of highest conducting NCPGE with an anodic decomposition limit of the electrolyte was stable up to 5.5 V vs. Li. The addition of nanosized silica into PGE enhanced the physical properties which is supported by the results of viscosity and Environmental Scanning Electron Microscope (ESEM). Fourier Transform Infrared (FTIR) spectroscopy was performed to study the molecular interaction between components in each electrolyte system. The complexities between the materials used in electrolyte system are divulged based on shifting of the bands, changes in intensity of the bands, changes in shape and existence of some new peaks in FTIR spectra. The highest conducting PGE and NCPGE were chosen as an electrolyte to fabricate Lithium-Oxygen battery. Lithium-Oxygen battery containing nanocomposite polymer gel electrolytes exhibits the most stable performance with higher discharge time and discharge capacity. The formation of discharge products (i.e. Li2O2 and Li2O) are also reduced since the nanosized silica particles enforcing their formation in only nanosize during discharge appear on the carbon air-electrode.