CHAPTER 7

SUMMARY AND CONCLUSIONS

We have successfully synthesized a series of polyacrylates and polymethacrylates containing six different alkyl lactates as pendant groups namely ML, EL, PL, i-PL, BL and i-BL. Mass spectrometric analysis of alkyl lactates, alkyl lactate acrylates and alkyl lactate methacrylates confirmed their formation by the appearance of M⁺ and/or M+1 peak and double hydrogen migration peak. Further, FT-IR, ¹H-NMR and ¹³C-NMR characterization studies confirmed the formation of alkyl lactates, alkyl lactate acrylates, alkyl lactate methacrylates, poly(alkyl lactate acrylate)s and poly(alkyl lactate methacrylate)s. <R> value of poly(alkyl lactate acrylate)s and poly(alkyl lactate methacrylate)s was found to be in the range of 5.56 - 5.75 Å and 6.26 - 7.18 Å respectively, depending upon the pendant groups. The length of the alkyl lactate group, RH and time determined the Mₑ values. Among the poly(alkyl lactate acrylate)s and poly(alkyl lactate methacrylate)s, PELA (9.1 % w/w) and PBLM (23.6 % w/w) shown the highest Mₑ values respectively. Moisture absorption of the homopolymers followed Fickian kinetic absorption. Increase in free volume decreased T_g as the side-chain length of n-alkyl lactate group increased. In the case of isoalkyl groups, bulkiness increased the T_g compared to its corresponding n-alkyl lactate (meth)acrylate polymers. Two-step thermal degradation was observed for all poly(alkyl lactate acrylate)s and poly(alkyl lactate methacrylate)s, except PELM and PBLM which exhibited single-step degradation in N₂ atmosphere. Activation energy for thermal degradation of poly(n-alkyl lactate
methacrylate)s was calculated by Ozawa and Kissinger’s methods. The existence of odd-even effect in poly(n-alkyl lactate acrylate)s and poly(n-alkyl lactate methacrylate)s was confirmed by FT-IR, WAXS, moisture absorption, contact angle and TGA studies.

Two series of copolymers namely poly(ELA-co-AA) and poly(BLM-co-AA) were successfully prepared by varying the comonomer content. FT-IR, $^1$H-NMR and $^{13}$C-NMR characterization studies confirmed the formation of copolymers. The calculated reactivity ratio of monomers were found to be $r_1 = 0.186$ (AA) and $r_2 = 0.101$ (ELA) for poly(ELA-co-AA) and $r_1 = 0.790$ (AA) and $r_2 = 0.393$ for poly(BLM-co-AA), which indicated that the synthesized copolymers had alternative arrangement and not as block or random. Increasing the ELA or BLM content in copolymers increased the $<R>$ values of copolymers. Depending upon the comonomer type, copolymer composition, relative humidity and time, the $M_e$ of copolymers can be successfully tuned to a wide range and it followed Fickian kinetic absorption. $T_g$ of copolymers decreased upon increasing the ELA or BLM content which was correlated with $<R>$ value of copolymers. Copolymers were thermally stable up to 150 °C in N$_2$ atmosphere and thermal stability of copolymers increased with increase in ELA and BLM content.

Two series of nanocomposites, PELA and PBLM with SP were successfully prepared by varying the SP content up to two weight percentage by solution casting technique. FT-IR and WAXS analysis confirmed the incorporation of SP with polymer matrix. $<R>$ value of nanocomposites decreased with increase in SP content. SEM and TEM analysis confirmed good dispersion of SP at 1 %w/w and agglomeration at 1.5 %w/w. $M_e$ of nanocomposites decreased marginally with increase in SP content and followed Fickian kinetic absorption. $T_g$ of nanocomposites increased with increase in SP content, indicated by decrease in $<R>$ value. Nanocomposites
were thermally stable up to 150 °C in N\textsubscript{2} atmosphere and thermal stability increased with increase in SP content. PELA nanocomposites exhibited two-step degradation, whereas PBLM nanocomposites exhibited single-step.

### 7.1 SCOPE OF FUTURE WORK

Among the studied poly(alkyl lactate acrylate)s and poly(alkyl lactate methacrylate)s, PBLM has highest M\textsubscript{c} and the value was 23.6 % w/w at 97 % RH and 30 °C. Among the copolymers, poly(BLM-co-AA)s have higher M\textsubscript{c} values in the range of 23.9 to 31.6 % w/w at 97 % RH and 30 °C, depending upon the BLM content in copolymers. Owing to its increased moisture absorption ability, both PBLM and poly(BLM-co-AA)s has tremendous potential for hydrogel applications. The work can be extended future by cross-linking their monomers and comonomers with a suitable material and performance with respect to hydrogel applications can be studied further in detail.