The mystery of nanotechnology has been progressively exposed in recent years. The field of nanotechnology is one of the most popular areas of current research and development in almost all science and technological disciplines. Among different nanocomposites polymer nanocomposites occupied a prominent position of current research and development owing to the remarkable improvement in the properties of pristine polymer over conventional composites or filled systems even at very low level of nanofiller content. Among various types of polymer matrices, epoxy resins represent one of the most fascinating thermosetting materials because of their versatile and tailorable structure-properties according to the desired need for a variety of applications.

Further, hyperbranched polymers have gained enormous attention to the scientific community over the last three decades because of their simple one-pot synthetic process; inherent characteristics of compact globular non-entangled structure; flexibility in tailoring; large numbers of terminal functional groups etc. Therefore an epoxy resin with hyperbranched architecture may serve as a unique matrix for the preparation of nanocomposites for the advancement of polymer nanocomposites which may open up different scopes for the researchers in the field of material science and technology. Thus in the present investigation a hyperbranched polyether based epoxy resin was synthesized by simple polycondensation technique. The resin was characterized by different analytical and spectroscopic techniques (FTIR, NMR, DSC, TGA etc.) to evaluate the different physical properties and structure of the resin. The performance characteristics of the poly(amido amine) cured epoxy thermoset was also evaluated to judge the suitability of the resin as advanced surface coating material. The hyperbranched epoxy resin was further modified with vegetable-oil based polyester resin to achieve the desired flexibility and toughness. The different modified systems were optimized with respect to the performance of the modified systems. The best modified system was achieved with 30 wt% of highly branched polyester content. The performance characters of the modified systems revealed the potential application of the modified systems as advanced thin film materials. To improve further performance of the modified system, formation of nanocomposites was carried out with different weight percentages of clay loadings (1, 2.5, 5 wt% with respect to the resin). The nanocomposites were characterized by different instrumental techniques (FTIR, XRD, SEM, TEM, Rheometer etc.). The performance characteristics of the nanocomposites
showed improvement of thermal and mechanical properties compared to the pristine systems. The other special properties like adhesive strength, anti-fungal activity, biodegradability were also found to improve after formation of the nanocomposites. However, the best performance nanocomposite was found with 2.5 wt% of clay loadings. The performance characteristics of nanocomposites showed the potentiality of these materials to be used as biodegradable antifungal thin film materials. Further, silver decorated clay nanocomposites of the modified hyperbranched epoxy were also prepared in order to achieve the antimicrobial activity of the prepared nanocomposites. The modified hyperbranched epoxy/clay-silver nanocomposites were characterized by various instrumental techniques (FTIR, XRD, SEM, TEM etc.) to corroborate the structure and morphology of the nanocomposites. The prepared nanocomposites showed improvement in the performance over their pristine systems. Moreover, the nanocomposites were found to have potential antimicrobial activity towards both gram positive and gram negative bacterial strains. Further the biodegradability and cytocompatibility of the nanocomposites revealed the potentiality of these nanocomposites as environmental friendly antibacterial thin film materials.