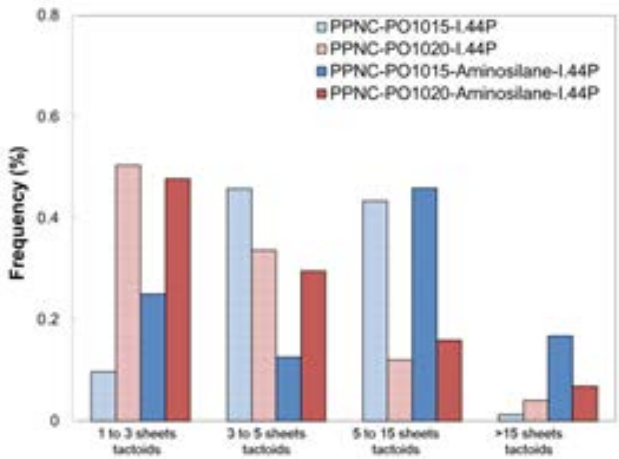
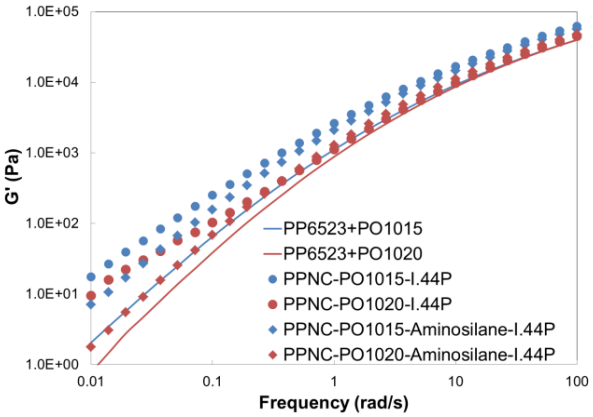
Polyolefin-Clay Nanocomposites with Coupling Agents

Sponsors: State of Michigan- MEDC, MIIE, and Petoskey Plastics, MI; Industry Collaborators: Tie Lan, Nanocor; Bryan Kazmer, ViChem; Dav Blankenhagen, Petoskey Plastics



Results obtained in Jayaraman's laboratory from this research show that the addition of organoclay with functionalized polymer or copolymer and other coupling agents to linear polyolefins can produce striking changes in the melt rheology of the bulk polyolefin that are beneficial for processing operations such as foaming and film blowing. Although obtaining good dispersion of organoclay in polyolefins is usually the aim of varying formulations and coupling agents, the objective of this work was to characterize different formulations not only for the degree of dispersion but also for dynamic shear moduli and extensional viscosity of different formulations in an attempt to understand the contributions from polymer particle contributions and from hindered relaxation of chains that are entangled with surface attached chains. Functionalized polymer chains can be attached to the organoclay both reversibly by hydrogen bonding and irreversibly by covalent bonding. The figures here present the state of dispersion and dynamic shear moduli for four different nanocomposite formulations comprised of long functionalized chains and shorter functionalized chains, organoclay without any silane, and organoclay trated with an aminosilane. Greater separation or exfoliation of nanolayer stacks is obtained by the functionalized polymer PO 1020 with more maleic anhydride but lower molecular weight. The dynamic storage modulus curves reveal that the higher molecular weight functionalized polymer PO 1015 has greater contributions from the entanglements between surface-attached polymer chains and free polymer chains; this also gives rise to greater enhancements in extensional viscosity behavior and melt strength for the nanocomposite.