



 Department of Chemistry

Functional Polymers for Lower Hysteresis and Enhanced Polymer/Filler Interaction

Presented by:

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The introduction of a polar group into a polymer chain is well documented in literature to reduce hysteresis and enhance polymer/filler interactions. This concept is based upon the use of functional initiators in anionic homo-polymerization of conjugated dienes and in the copolymerization of conjugated dienes and vinyl aromatic compounds. Greater improvements were realized when these functional initiators were used in conjunction with cyclic amines and were placed at the front end of the polymer chain. Different functional groups produced varying results, where the most effective group proved to be an amine attached to an aromatic ring.

With these initial results, the promising field of functional initiators was further studied. For example, researchers at Nippon Zeon were able to utilize the Michlar Ketone reaction and attach these groups to the polymer chain end. Nearly each and every functional initiator or functional group at the polymer chain end resulted in enhanced polymer/filler interaction and reduced compound hysteresis, without sacrifice in wear or wet traction.

The addition of a primary amine catalyzed with an organo-lithium diisopropenyl benzyl compounds to divinylstyrene is well documented in the literature. Tsuruta and associates published several papers in this field. They prepared 1-(2 diethylaminoethyl)-4-vinyl styrene by the reaction of diethylamine and trivinylbenzene catalyzed by n-butyllithium. At the Goodyear Tire & Rubber Co. the exploratory polymer research group began to investigate the concept of using functionalized monomers in anionic polymerization. By employing this same technique and the Michael Reaction approach, the group prepared several functional monomers of both divinylbenzene and diisopropenylbenzene derivatives. Using n-butyllithium, these reactions were catalyzed by the addition of pyrrolidine, piperidine, morpholine, hexamethylene imine to the divinylaromatic compounds. The final products for divinylbenzene were isolated and identified as:

- 1-(2-piperidinoethyl)-4-vinylbenzene
- 1-(2-pyrrolidinoethyl)-4-vinylbenzene
- 1-(2-morpholinoethyl)-4-vinylbenzene
- 1-(2-hexamethyliminoethyl)-4-vinylbenzene.

These functional monomers were then copolymerized (from a concentration of 0.25% to 20%) with the conjugated diene and vinylaromatic using organolithium initiators in hydrocarbon solvent. The resulting solution SBR contained 0.25% to 20% of these functional monomers in random non-blocky elastomers. These copolymers were evaluated in tread rubber formulations to determine their effects on rolling resistance and wear properties. The results are discussed in full detail in the following paper.