**Ultrasonically Aided Extrusion Processes for Decrosslinking of Crosslinked Polyethylenes**

*Avraam I. Isayev, Department of Polymer Engineering, The University of Akron, Akron, OH 44325-0301*

[aisayev@uakron.edu](mailto:aisayev@uakron.edu)

**Abstract**:

The problem of recycling crosslinked plastics waste, including crosslinked polyethylenes (XPEs), is a tremendous environmental challenge. The XPEs are used for manufacturing durable and strong packaging, cable and wire insulation, large storage containers and various pipes and conduits. During their production a waste is generated and at the end of the product life the materials are discarded, creating a tremendous amount of waste. A new ultrasonic single- and twin-screw extrusion technology was developed in our laboratory to manufacture new materials and products from waste XPEs. These recycled materials are suitable in a variety of applications. Extensive experiments were conducted on peroxide-crosslinked high density polyethylene (XHDPE) and low density polyethylene (XLDPE). Extrusion process characteristics are established. Structural, rheological, thermal, morphological and mechanical studies were carried out to elucidate the structure-property relationship of decrosslinked XPEs. It was found that a more intensive rupture of the crosslinked network occurs at higher degree of crosslinking. Analysis based on the normalized crosslink density - gel fraction function showed that the type of preferential bond breakage during decrosslinking was not determined by the bond energy alone but also influenced by structural characteristics of the crosslinked network. The activation energy of viscous flow of sols extracted from various decrosslinked XPEs supported this analysis. The dynamic, thermal and tensile properties of the decrosslinked XPEs were greatly affected by the type of preferential bond breakage. A significant improvement in the processibility and mechanical properties of decrosslinked XPE was achieved due to the occurrence of a highly preferential breakage of crosslinks during ultrasonic decrosslinking. Modeling and computer simulations of the ultrasonic treatment of XPEs were also carried out with aim to optimize the conditions of treatment and to design more efficient ultrasonic extruders.

**Biography:**

Dr. Avraam I. Isayev is Distinguished Professor of Polymer Engineering at University of Akron and Editor-in-Chief of Advances in Polymer Technology. He received his Ph.D. in Polymer Science and Engineering, Institute of Petrochemical Synthesis of USSR Academy of Sciences, Moscow; M.Sc. in Applied Mathematics, Institute of Electronic Machine Building, Moscow, USSR; M.Sc.in Chemical Engineering, Azerbaijan Institute of Oil and Chemistry, Baku, USSR. Prior to joining the University in 1983, Isayev conducted research at Cornell University, Israel Institute of Technology, USSR Academy of Sciences, and State Research Institute of Nitrogenic Industry, USSR. His research interests focus in polymer and composite processing, process modeling, rheo-optics, rheology and constitutive equations of polymers, oil products and disperse systems; the injection, co-injection, transfer, compression and gas-assisted injection molding; processing of self-reinforced or in-situ composites based on blends of flexible and thermotropic liquid crystalline polymers; decrosslinking of thermosets, devulcanization of rubbers and in-situ copolymer formation in immiscible blends with the aid of ultrasonic waves; high temperature and high performance nanocomposites. Isayev has co-authored 2 editions of 1 monograph, edited or co-edited 7 books, published over 240 papers in journals, 33 chapters in books, 7 papers in encyclopedias, 160 papers in conference proceedings. He holds 26 patents. He advised 43 PhD, 39 MS students and 29 postdocs and visiting scientists. He serves on editorial and advisory boards of many journals.His research was featured in the *Boston Globe*, *Plastics Technology, Rubber and Plastics News, AAAS Science Update*, *Popular Science*, *Business Week, Architect Magazine, Tire Technology International, PBS TV and other publications around the world.* Isayev is the recipient of the Young Scientist Award (Moscow), the OMNOVA Solutions Signature University Award from the OMNOVA Solutions Foundation, The Melvin Mooney Distinguished Technology Award and The Stafford Whitby Award from Rubber Division of the ACS, the Silver Medal from the Institute of Materials (London), the Vinogradov Prize from the G. V. Vinogradov Society of Rheology (Moscow), the NorTech Award given by Crane Publishers, James L. White Award of PPS and the Society of Plastics Engineers (SPE) International Award. He is SPE Fellow.