Stevens Institute of Technology

Nanotechnology Graduate Program

Novel Ultrasonic Extrusion Process for Manufacturing of Polymer Nanocomposites

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Layer-silicate, carbon nanofiber (CNFs) and carbon nanotube (CNTs) based polymer nanocomposites have attracted considerable interest due to potential improvements in thermal, rheological, mechanical and physical properties of polymers. The unique morphology and strong inter-tube attractions makes the dispersion of CNTs and CNFs a big challenge and hence limits their effective use. Also, significant difficulties exist to intercalate/exfoliate nanoclays in polymer matrices, especially polyolefins, using existing melt processing techniques. A novel method for the continuous dispersion of CNFs, CNTs and for intercalation/exfoliation of nanoclays in polymer matrices for manufacturing nanocomposites was developed using an ultrasonically assisted twin screw and single screw extrusion processes. The process is intended to replace the currently used inefficient technology requiring a multi-step batch solution process with prolonged ultrasonic irradiation (minutes and hours) followed by the removal of solvent. The effect of ultrasound on die pressure, electrical conductivity, rheological, morphological and mechanical properties of various nanoparticle-polymer systems was studied. Ultrasonic treatment caused a reduction in die pressure and resulted in enhanced dispersion of CNTs and CNFs and exfoliation of nanoclays. The prepared materials have unique combinations of rheological, mechanical, electrical and thermal properties and improved permeability making them ideal for use in various applications.

Avraam I. Isayev is a Distinguished Professor of Polymer Engineering at the University of Akron. He received his M.Sc. in Chemical Engineering from Azerbaijan Institute of Oil and Chemistry, Baku, USSR, M. Sc. in Applied Mathematics from Institute of Electronic Machine Building, Moscow, USSR and Ph. D. in Polymer Engineering and Science from Institute of Petrochemical Synthesis of the USSR Academy of Sciences, Moscow. His research interests are polymer, composite and nanocomposite processing, various molding processes, process modeling, rheo-optics, rheology and constitutive equations of polymers, oil products and disperse systems; 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. His work has been featured in numerous publications around the world, including the Boston Globe, Plastics Technology, Rubber and Plastics News, AAAS Science Update, Popular Science and Business Week. He is the recipient of the Outstanding Researcher Award from The University of Akron Alumni Association, the OMNOVA Solutions Signature University Award from the OMNOVA Solutions Foundation, the Melvin Moony Distinguished Technology Award from the American Chemical Society (ACS) Rubber Division, the Silver Medal from the Institute of Materials (London), the Vinogradov Prize from the G. V. Vinogradov Society of Rheology (Moscow). He is a Fellow of the Society of Plastics Engineers. He has published 215 journal articles, 29 chapters in books, 5 papers in encyclopedias and has edited or co-edited four books and co-written one monograph. He holds 26 patents. He serves on eight editorial and advisory boards of international journals. Prior to joining the University in 1983, he conducted research at Cornell University, the Israel Institute of Technology, the USSR Academy of Sciences, and the State Research Institute of Nitrogen Industry, USSR.

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