TECHNOLOGY UPDATE

Nano Particle Reinforced Polyamide-based Polymers for Catheter Shafts

Foster has been at the forefront of incorporating nano particles in plastics used for thin wall medical catheter components. Polyamide-based polymers, including nylon 12 and polyether-block amide (Pebax®), are materials of choice for catheters used in diagnostic and interventional cardiology. Our researchers evaluated multiple loading levels of nano particles in polyamide-based polymers to quantify improvements in mechanical performance and identify the loading range in which flexibility and ductility of the blend is preserved.

Nano Particle Technology

Nano particle reinforced polymers incorporate particles that are less than one nanometer in thickness or diameter with aspect ratios (length: thickness) in the 300:1 to 1,500:1 range. These nano particles approach the size of the polymer molecules and interact at the molecular level to immobilize portions of the polymer chain creating a reinforcement effect.

Small quantities of nano particles dispersed throughout the polymer matrix result in a vast number of constrained areas and leads to reinforcing effects significantly higher than traditional reinforcing agents, such as glass fiber. These low loadings allow for retention of polymer toughness properties. The low loadings also preserve surface finish and weight of the blend.

Processing Technology

Nano clay particles are inherently difficult to blend with polymers without clumping together (known as agglomeration). These particles must be specifically treated in a proprietary process for separation, or opening up the spaces between the particles, known as intercalation. This is necessary to allow the polymer to flow around all nano-particles during compounding without agglomeration.

Foster's advanced twin-screw compounding technology includes carefully established and monitored mixing screw profiles, speeds and pressures that maximize dispersion of particles without degradation of the host polymer.

Test Results

At very low loading levels of 3% nano clay reinforcement in Pebax® 7233 (polyether block amide) and Rilsan® AESNO (nylon 12) flexural modulus improved 36% and 26%, respectively. Flexural modulus is a material property often associated with pushability and torquability in catheter shafts. Tensile elongation, a property often associated with ductility of the polymer, decreased by 45% and 61%, respectively, in these samples.

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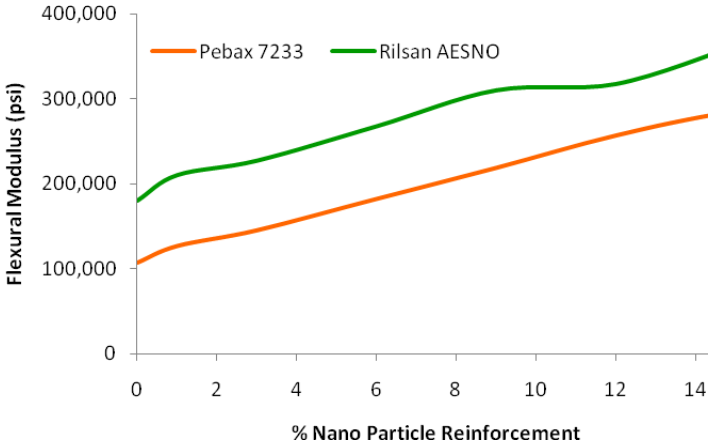
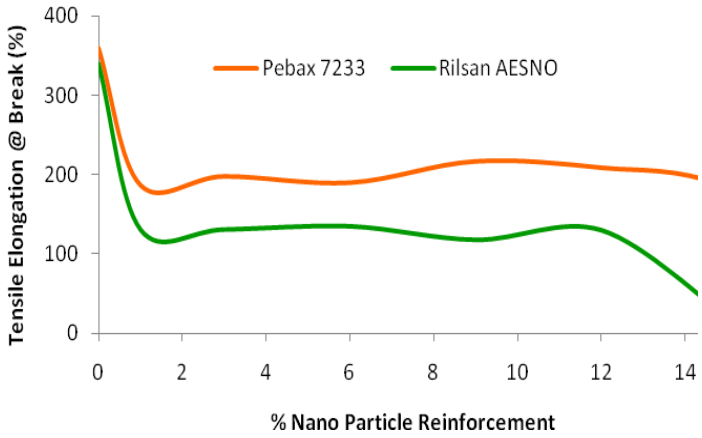
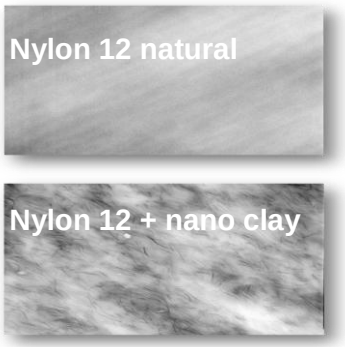




However, at slightly higher loadings of nano clay there was a measurable improvement in flexural modulus without additional reduction in elongation. The flexural modulus improved by 140% for Pebax 7233 with 12% nano clay while the elongation was reduced by 42%, compared to natural Pebax 7233. The flexural modulus for Rilsan AESNO increased by 76% compared to the natural sample, while elongation reduced by 62%.



Dispersion of the nano clay particles is not only critical for improvement of mechanical properties while preserving ductility, it is also critical for surface finish and maintaining dimensions in thin wall catheters. Microscopic evaluation of the samples demonstrated homogenous distribution of the nano particles within the matrix.

This study designed to evaluate nano clay particles in common catheter shaft materials to determine the optimal loading levels for improvement in flexural modulus while maintaining tensile elongation properties. Future studies are required to further quantify additional attributes believed to be associated with nano clay compounds, such as improved barrier properties, thermal properties and flame retardant properties.

About Foster

Foster Corporation supplies custom biomedical polymers for the medical device industry, including custom compounds for minimally invasive devices, polymers blends for implants, and drug/polymer blends for combination products. For more information, please call or visit us at:

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