Precisely controlled nanoparticle distribution to develop strong and tough composite materials

While crystalline polymers are widely used because of their high ductility, it is still very challenging to expand their use in structural applications, due to the lack of adequate strength. Current methods increase the polymer strength by creating a uniform distribution of nanoparticles through a multi-step process and are often cumbersome and lack flexibility. This technology is a process to tailor the spatial distribution of nanoparticles by controlling the rate of crystallization. This technology enables more precise control over the strength and other characteristics of the polymers in a single step process. As such, this technology provides a simple, controlled and robust process to manufacture versatile composite polymers with strength and toughness.

Simplified and controlled crystallization process to manufacture strong polymers for alternative applications

This technology overcomes the challenge of manufacturing strong polymer composites with a controlled single-step crystallization process. By controlling the distribution of nanoparticles within a polymer matrix, this technology is able to increase the strength of polymers, and ultimately enables their use in structural applications. The PMMA-g-silica nanoparticles are first evenly distributed in a PEO polymer matrix and solidified prior to the crystallization process. Through an isothermal crystallization process using differential scanning calorimetry (DSC), these nanoparticles are organized into a layer-by-layer morphology. While the conventional technology focuses on creating a uniform spatial distribution of nanoparticles, this technology can tailor the distribution and enable control at the nanometer scale. Furthermore, the inclusion of nanoparticles does not significantly affect the thermodynamic properties of the polymer matrix. Thus, versatile composite materials that exhibit both toughness and rigidity may be achieved with this simple and controlled process.

A prototype of the technology has been tested and the resulting polymers have been shown to be tough and strong.
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Applications:

- Durable polymers for use in petroleum industry
- Making light materials for use in aerospace or automobile industries
- Tailoring materials to fit specific requirement for military uses
- Manufacturing composite materials that are both strong and tough
- Adapting process to develop polymers for drug delivery
- Manufacturing fibers with specific characteristics

Advantages:

- Simplified process
- Higher level of control
- Increased versatility
- Less restriction on process condition, specifically nanoparticle concentration

Patent Information:

Patent Pending

Tech Ventures Reference: IR CU15186

Related Publications:

- Zhao D, Jestin J, Zhan L, Kumar S, Mohammadkhani M, Benicewicz B. “Semi-crystalline polymer nanocomposites: interplay of matrix crystallization and nanoparticle self-assembly” Volume 60, Number 1, APS March Meeting 2015

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