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Developments in 1,5-Pentanediamine based polyamides as an Innovative Next-Generation Bio-based and Renewable Polymer

Cathay Industrial Biotechnology has announced Terryl®, a commercially new bio-based polyamide 56 (PA56) for the fiber and textile markets. This new polyamide is based upon a new bio-based and renewable diamine also produced by Cathay Biotech, 1, 5-pentanediamine (5DN), and offers these markets significant improvements in moisture management, strength, comfort, flame resistance and dyeability.

Because 5DN eliminates one diamine carbon compared with HMDA, the perfect hydrogen bonding alignment observed in PA66 is significantly disrupted. This results in an increase of over two orders of magnitude in available dye accepting sites for Terryl®. In addition, these newly available carbonyl and amine groups are also available for the absorption and internal transfer of water. This disruption is predicted to also improve other key attributes including dyeability, softness, flowabilty/viscosity while simultaneously not affecting the strength and wear resistance provided by PA66. It is also anticipated that improved dyeability will result in reduced fiber spinning costs when compared with PA66.

Compared with PA66, Terryl®'s fabric had superior elastic recovery, moisture absorbance and wicking (ΔMR), comfort, and dyeability. Terryl™ carpet fibers dyed as deeply at room temperature as PA66 fiber at high temperature. Under the same dyeing conditions, Terryl® carpet, hosiery and seamless underwear dyed deeper and more color fast than PA6 or PA66. By saving energy, chemical dye, and off-grade wastage, using Terryl® improves both environmental footprint and fiber cost. Exceeding our expectations, Terryl® also had significantly improved flame retardant properties. The limiting oxygen index (LOI) is the minimum concentration of oxygen that will support combustion of a polymer. Terryl®'s LOI is in the 32-34% range and is significantly higher than PA6, PA66 or polyester. Terryl®'s LOI provides two additional benefits: first, addition of flame retardants can be reduced or eliminated, reducing cost and secondly, reducing the level of flame retardants may positively impact spinnability, which also reduces costs.

Terryl® is 46% biobased carbon. The environmental impact of 5DN production is a fraction of that required for HMDA. The CO_2 emissions for 5DN production have been determined to be approximately 4 kg CO_2/kg 5DN, as compared to 8-16 kg CO_2/kg for HMDA. In addition, the primary energy demand for 5DN production is one-third to one-half that of HMDA, with a significant portion of 5DN's primary energy demand coming from renewable sources. Cathay Biotech also has technology to produce 5DN from biomass which would further reduce the CO_2 emissions for 5DN to less than 3 kg CO_2/kg 5DN.

The favorable 5DN CO_2 contribution versus HMDA reduces the CO_2 emissions of Terryl® by 27% over PA 66.

In addition to Terryl®, the functionality and market potential of other 5DN based polyamides will be discussed.