STUDIES ON DRY-JET-WET SPINNING OF POLY(LACTIC ACID) FILAMENT AND ITS KNITTING

By

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Spinning - poly filament

CERTIFICATE

This is to certify that the thesis entitled 'Studies on dry-jet-wet spinning of poly(lactic acid) filament and its knitting' submitted by **Mr. Nilesh S. Revagade** has been prepared under my guidance with the rules and regulations of Indian Institute of Technology Delhi, India. The research reports and results presented here in this thesis have not been submitted for any degree or diploma in any other institute or university.

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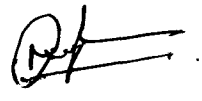

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ABSTRACT

With the decline in petroleum reserves and environmental hazards of synthetic polymers the importance of the biodegradable polymers is continuously increasing for the last two decades. Research in the area of poly(lactic acid) (PLA) shows strong promises in this regard because of its availability from renewable sources and important property of biodegradability. Also the processing requirements of PLA match with the existing processing technologies which makes it a strong alternative for other commercial polymers. The conversion of PLA into textile fibres can be done by melt spinning or by solution spinning, but each process has certain shortcomings associated with it. In this present work, the spinning of PLA by dry-jet-wet technique was investigated and extensive study of properties of developed PLA fibres after post spinning operation was carried out.

The PLA monofilaments were prepared by dry-jet-wet spinning technique using chloroform and methanol as solvent and nonsolvent, respectively. The as spun PLA monofilament was further subjected to post spinning operations *i.e.* hot drawing and heat setting to achieve required physical characteristics. The effect of various process parameters such as draw ratio, drawing temperature, heat setting temperature and take up speed on the structure and properties of PLA monofilament are reported. The characterization of the resultant monofilaments was carried out by various techniques, such as differential scanning calorimetry (DSC), X-ray diffraction analysis, scanning electron microscopy (SEM), sonic modulus and tensile testing.

The process has various advantages over conventional PLA filament spinning processes. The most attractive feature of this spinning process is that molecular chain degradation remains very low *i.e.* of the level of 9.15% as

compared to other conventional spinning processes. It is observed that the optimum take up speed for filament spinning is 10 m/min. The best filament properties are achieved by drawing the filament at draw ratio of 8, drawing temperature of 90°C and heat setting temperature of 120°C. The filament with tenacity of 0.60 GPa and modulus of 8.2 GPa is developed by this process.

The applicability of PLA filaments in the medical field were investigated by developing and studying its knitted structures as scaffold device. The mechanical properties of the weft knitted structure with 8 ply PLA filaments was observed to be maximum with bursting strength of 53.7 Kg. Also the porosity of the same fabric observed to be 80% which is suitable for the desired application.

The *in-vitro* degradation study of PLA filaments and knitted structures was carried out at three different pH and properties are characterized. The degradation is observed to be the highest at pH 4.6 as compared to of pH 7.4 and 8.0. The acidic environment seems to be more hostile to the filament and fabric structures. The surface morphology of the filaments and knittings also showed severe degradation in the form of porous structure at a pH of 4.6 as compared to pH 7.4 and 8.0.

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