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**HIGH LUSTER POLYAMIDE FILAMENTS AND
PROCESS FOR PRODUCING THEM**

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This invention relates to a process for the production of filaments from synthetic linear polyamides. These polymers are made by subjecting bifunctional polyamide-forming reactants to polymerising conditions until the polyamide formed is capable of being melt-spun into filaments which can be "cold-drawn," i. e. elongated under application of stress in the solid state, with a consequent improvement in mechanical properties. As polyamide-forming reactants there may be used, for example, a polymerisable amino acid, or a derivative thereof, or a mixture of one or more diamines and one or more dibasic acids or their amide-forming derivatives.

It is an object of the present invention to provide a process for the production of polyamide filaments having mechanical and surface properties which render them particularly suitable for use in brush tufting and other applications.

This object is achieved by a process for the production of polyamide filaments by extruding a molten synthetic linear polyamide and quenching it by contact with a liquid which has substantially no solvent action on the polymer under the conditions used, characterised in that the quenching liquid is maintained at a temperature below -5°C . The filament is subsequently cold-drawn by any of the known methods. For example, the filament may be passed from one or more rolls rotating at a given speed to one or more draw rolls rotating at a sufficiently greater speed to bring about the required elongation of the filament. Preferred draw ratios are 3:1 to 6:1. My invention also comprises polyamide filaments made by the above processes.

I prefer to quench the extruded filament by means of a liquid at between -25°C . and -60°C . By using a quenching liquid below -25°C . filaments having an optimum combination of mechanical and surface properties are produced. Temperatures below -60°C . are not normally used as little improvement in filament properties is obtained under these conditions compared with the improvement obtained by working within our preferred temperature range and to maintain the liquid at such low temperatures involves additional cost.

Examples of suitable quenching liquids are alcohols, ketones, ethers, esters, hydrocarbons, chlorinated hydrocarbons and aqueous solutions of salts which are liquid at the temperature at which it is desired to quench the extruded filament. Particularly good results have been obtained using methyl alcohol and trichloroethylene. The quenching liquid may be used in the form of a bath or a spray although the former is usually more convenient.

To obtain the optimum effect the temperature of the polyamide should not be materially below its melting point when it comes into contact with the quenching liquid. In the preferred method of carrying out the present invention therefore, the molten polymer is extruded directly into the quenching liquid to prevent any preliminary cooling due to the action of air.

The polyamide filaments may, if desired, be coloured by, for example, incorporating a suitable colourant in the

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polymer or in an intermediate used in its production or, alternatively, the filaments may be treated with the colourant after extrusion. When making relatively large quantities of filaments in one colour, we prefer to incorporate the colourant by dispersing it in the molten polymer prior to its extrusion. On the other hand, for comparatively small batches, it is preferred to colour the extruded filaments by dyeing.

Excellent results are obtainable in accordance with the present invention using a polyamide derived from hexamethylene diamine and adipic acid. Particularly useful filaments are also obtained by the application of the present invention to an interpolyamide obtained by polymerising together a mixture of hexamethylene diammonium adipate and hexamethylene diammonium sebacate in weight proportions of about 80% of the former to about 20% of the latter. My invention may also be applied to the production of filaments of polymerised caprolactam.

Polyamide filaments which have been extruded and quenched according to the present invention are highly transparent, smooth and of very attractive appearance. After they have been cold-drawn, the filaments are of high tensile strength and retain their attractive surface lustre. The cold-drawn filaments of our invention, especially those having a diameter within the range of 0.005" to 0.023", are particularly suitable for filling brushes and the like. In order to increase their ability to recover after deformation, it is normally desirable to condition the cold-drawn filaments by treating them with hot water or steam, preferably under tension. For example, a reel of the filaments may be immersed in boiling water for 30 to 90 minutes. The surface smoothness of these filaments enables them to be handled easily in conventional brush-making machinery. My invention, therefore, also comprises brushes, e. g. brooms, filled with cold-drawn, preferably conditioned filaments made by the process of my invention.

If it is desired to produce tapered filaments, cyclic variations in the haul-off rate of the extruded and quenched filaments can be applied in the usual manner. It will also be appreciated that, if desired, crimping, tipping or flagging may be carried out by any of the known methods.

My invention is illustrated but in no way limited by the following example.

Example

Polyhexamethylene adipamide of number average molecular weight approximately 11,500, containing 0.05% by weight of a cadmium yellow pigment, was extruded at 300°C . through a circular orifice of 0.030" diameter at a rate of 1.2 lb./hr. The extruded monofilaments were passed at a speed of 100 ft./min. through a bath containing trichloroethylene maintained at -45°C . by the addition of Drikold and thereafter cold-drawn to four times their original length. The cold-drawn filaments were held under tension in boiling water for 45 minutes. Throughout the drawing and subsequent treatment the monofilaments retained their very attractive appearance and smooth surface. The tensile strength of these filaments measured at 100% relative humidity was 53,400 lb./sq. in. compared with a figure of 51,200 lb./sq. in. shown by filaments made by repeating the above process but using a water bath at 25°C . for quenching.

I claim:

1. A process for the production of polyamide filaments comprising the steps of extruding a molten synthetic linear polyamide, and quenching the extruded polyamide by contact with a liquid having substantially no solvent action on the polymer and maintained at a temperature below -5°C .

2. A process as defined in claim 1, in which the tem-

perature of the quenching liquid is maintained at a temperature between -25°C. and -60°C.

3. A process as defined in claim 1, in which the quenching liquid is methyl alcohol.

4. A process as defined in claim 1, in which the quenching liquid is trichloroethylene.

5. A process as defined in claim 1, in which the polyamide is polyhexamethylene adipamide.

6. A process as defined in claim 1, in which the quenching filament is subsequently cold-drawn.

7. A process as defined in claim 1, in which the

quenching filament is subsequently cold-drawn, and then subjected to high temperature in an aqueous medium under tension.

8. Polyamide filaments produced by the process of claim 1.

References Cited in the file of this patent

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