Melt Spinning of Potentially Electroactive Textile Fibres

and the Influence of Melt Spinning Parameters on Molecular Structure Development

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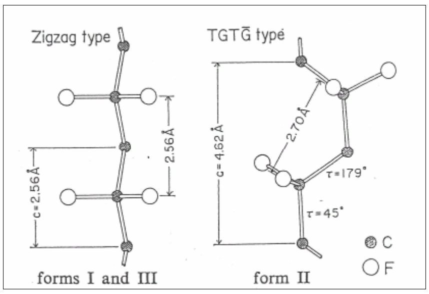

Figure 1 Molecular structure of the polar β-phase (form I) and the non-polar α-phase (form II) *Reproduced from Ref 1, with permission*

Poly(vinylidene fluoride) (PVDF) is a polymorphic polymer which, when made to crystallize in its polar (β-)form, see Figure 1, yields piezo- and pyroelectric properties. In present work, the effect of varying parameters in melt spinning on the formation of β-phase crystallinity was investigated.

PVDF fibres were melt-spun using four different draw ratios in the melt, and subsequently drawn in the solid state up to the highest possible draw ratio. The maximum solid state draw ratio was dependent on the melt draw ratio used, see Table 1.

Fibres drawn only in the melt showed mainly non-polar α-phase crystallinity, and cold drawing was necessary to achieve α- to β-phase conversion (Figures 2 & 3). Using a high melt draw ratio produced fibres with a high degree of crystallinity, and a high draw ratio in cold drawing gave a high degree of β-phase crystallites.

The higher the melt draw ratio is, the lower the maximum draw ratio in cold drawing becomes, but a relatively low draw ratio in the cold drawing step may be compensated by a high draw rate, as a high draw rate seems to promote β-phase crystallinity (Figure 3).

The results indicate that with some fine-tuning of the spinning parameters, it is possible to produce PVDF fibres with high crystallinity (above 80%) and almost completely in the β-form.

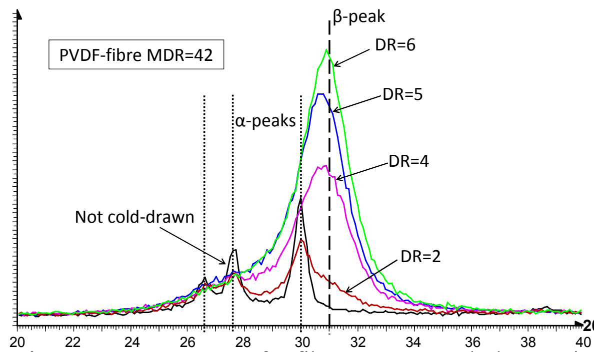

Figure 2 XRD-patterns for fibres spun at melt draw ratio 42, before and after cold drawing

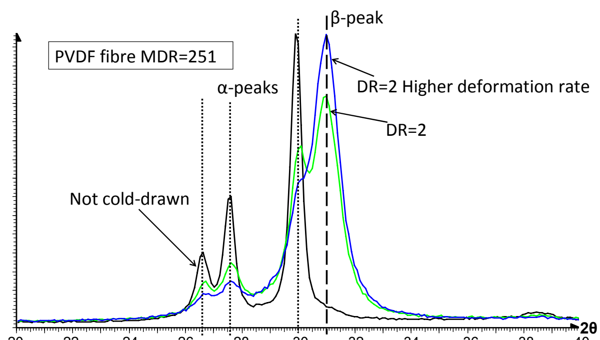

Figure 3 XRD-patterns for fibres spun at melt draw ratio 251, before and after cold drawing

Table 1 Parameters used in melt spinning and cold drawing

Fibre denotation	Melt draw ratio MDR	Solid state draw ratio DR	Draw rate solid state (min^{-1})
PVDF-MDR42	42	2	7.6
		4	22.8
		5	30.4
		6	38.0
PVDF-MDR84	84	2	7.6
		3	15.2
PVDF-MDR251	251	2	7.6
		2	15.2
PVDF-MDR419	419	Not cold-drawn	

Ref 1: Hasegawa, R. et Al., *Polymer Journal*, 3 (5), 591-599, **1972**

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