Introduction
During some manufacturing processes for polymeric products, such as injection molding or film blowing, the material is under shear and elongational flow resulting in an oriented microstructure after crystallization which leads to anisotropic mechanical behaviour. The objective of this work is to model the orientation induced anisotropic behaviour of semi-crystalline HDPE.

Micro-mechanical model
At the microscopic level, the material is considered to be composed of amorphous and crystalline phases forming a composite inclusion as shown in Figure 1.

The deformation behaviour of the material is obtained as the volume average of the response of an aggregate of composite inclusions, using a hybrid mean-field approach. In hot-drawn tapes, the crystalline domains show a preferred orientation distribution. Figure 2 shows the orientation distribution of a sample of drawn HDPE with a draw ratio of 4.

In addition to the crystalline domains, also the amorphous regions are in a pre-oriented state causing an internal stress.

Motivation
Samples are obtained from oriented HDPE tape at different angles, see Figure 3.

Figure 3: Schematic representation of the samples obtained from oriented HDPE tape.

Figure 4 gives a comparison of the tensile yield kinetics obtained in experiments and simulations in case of only a preferred orientation of the crystalline domains.

Conclusion and future research
The modified micro-mechanical model, including a pre-stretched EGP model, will be used to capture the effect of a pre-oriented amorphous phase on the overall response of oriented HDPE films with different draw ratios, under different strain rates and eventually different temperatures. The model predictions will be compared more comprehensively against experimental results.

References: