The Relationship Between the Degree of Entanglement Density Set up by pre-swelling and the as-spun UHMWPE fibers ' Structure and Property

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Introduction

Due to the reason that the development of human society 's demand for energy is increasing, the demand for uranium resources is also increasing. And researchers start to be interested in extracting uranium from seawater. Decades ago, The study on extracting from seawater originated in English , but until recently , polyethylene -based adsorbent developed by Japanese researchers achieved relatively good results in extraction of uranium. Besides, American researchers have just made some breakthrough too. By analyzing the findings of recent study, we find that obtaining Polyolefin fibers with high specific surface area is the key to improving the efficiency of extraction of uranium. For example, Oak Ridge Laboratory achieved a five-folded improvement in the efficiency of extraction of uranium by developing micron -scale fibers with profiled cross-section.

According to the theoretical calculations based on shish-kebab model, we find that the specific surface area of polyethylene fibers with shish-kebab structure is much higher than profiled fiber. Therefore, the prospect of developing UHMWPE fibers with shish-kebab structure is very promising.

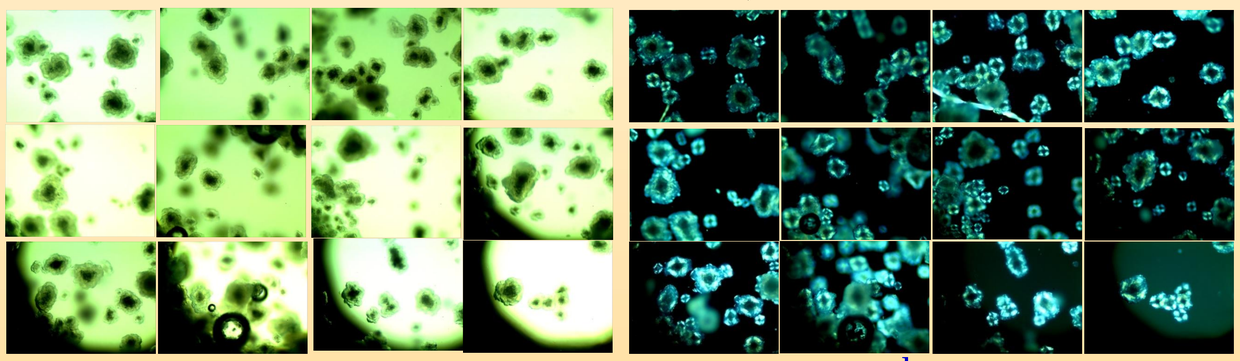
Generally speaking, there are two typical morphology of as-spun UHMWPE fibers ,namely lamellae structure and shish-kebab which are largely influenced by the degree of entanglement density set up by pre-swelling, spinning speed, stretching in the spinline, molecular weight and molecular weight distribution. And the structure of as-spun UHMWPE fibers does have a great effect on the strength and structure of final product after hot-drawing process.

In order to study the structure changing mechanism of UHMWPE fibers induced by hot-drawing with in-situ SAXS\WAXS aiming at providing theoretical support for developing ideal fibers, We design and manufacture rheological stretching device and temperature control box.

Experiments and data

5wt%UHMWPE solution, pre-swelling at 25℃， take sample every 10min，observe with Polarized Light Microscope

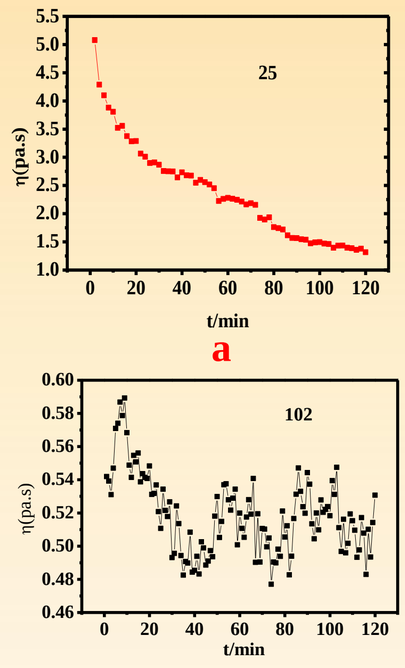
time increasing



a b

Figure 1 the morphological changes of 5wt%UHMWPE solution after pre-swelling as time increasing. (a) OM images，(b) PLM images.

In order to study the effect of the pre-swelling process on gel-spun UHMWPE fibers and decide the pre-swelling time ,we observe the morphological changes of 5wt%UHMWPE solution after pre-swelling process with OM and PLM method . From Figure 1(a) we find that UHMWPE power is Surrounded by paraffin oil. As the swelling time increase ,the UHMWPE power begin to swell ,but not that obvious, and the powers have the trend of spreading in the solution, which is beneficial to further dissolution in twin-screw extruder.



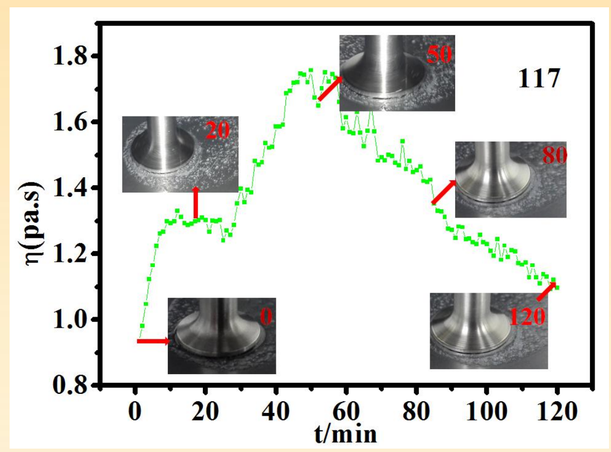


Figure 2 the viscosity changes of 5wt% UHMWPE solution as time increasing with Plate rheometer. a at 25℃ b at 117℃ c at 102℃

As we all know, if UHMWPE powders in paraffin oil begin to swell, the viscosity will change as time goes during pre-swelling process. In order to study the relationship between the degree of entanglement density set up by pre-swelling process and the as-spun UHMWPE fibers 'structure and property, we conduct measurement on the viscosity changes at different temperature.As Figure2 b shows, there are two peaks at about 20minute and 50 minute, and with time increasing, the UHMWPE powers begin to swell and look like snowflake in paraffin oil

Instruments

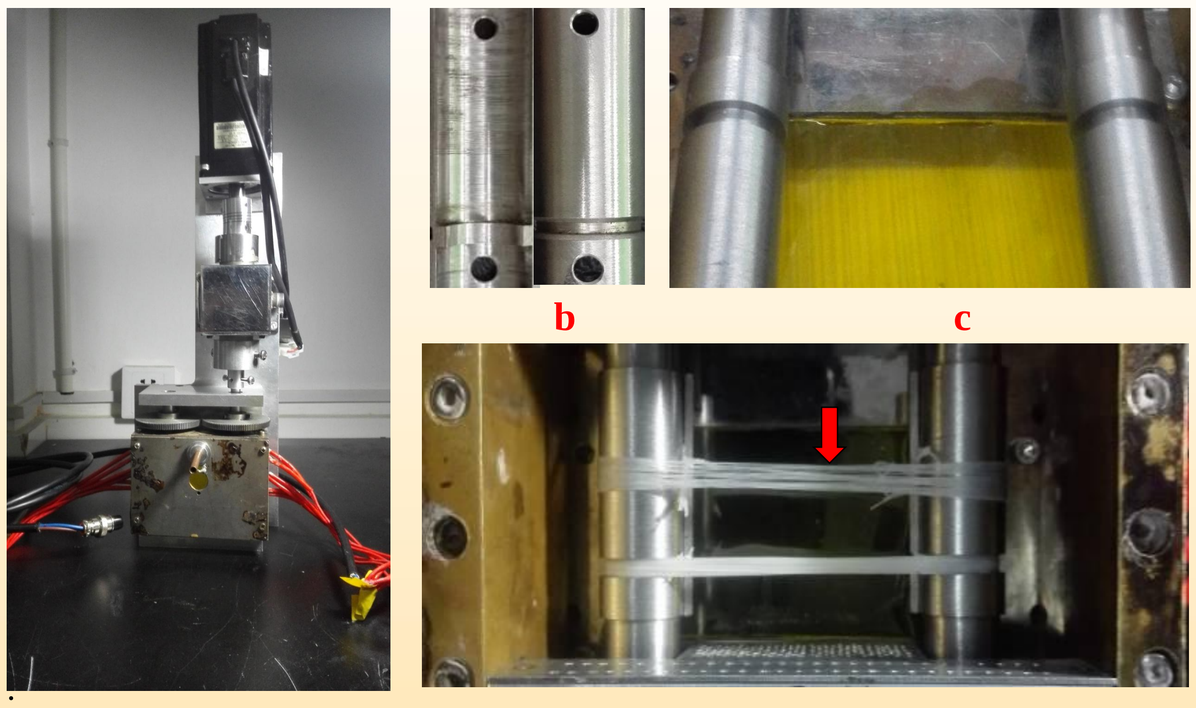


Figure 3 (a) stretching device for hot-drawing UHMWPE fibers (b) sample clip (c) axis with a slot (b) the different state of fibers after stretching

If we place fibers with the help of ordinary clips and axis, fibers may spread to both sides along the axis(as the red arrow shown in Figure 4(d)), which make it difficult for in-situ SAXS detection. For this reason, we design a new axis with a slot(Figure4 c)and new clips(Figure4 b).

Annual Plan in 2015

i. Continue reading more articles about gel-spinning UHMEWPE fibers and hot-drawing fibers, so as to producing better fibers for next study
ii. Make a new temperature control box
iii. Consummate the research plan on in-situ SAXS study the structure changes law of fibers stretching at high temperature

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