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Dynamic Mechanical Analyses for molecular level engineering of advanced subsea polymers

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Introduction

Due to declining onshore reserves, operators have turned to deep waters prospects to supplement production [1]. It is therefore important that reliable and efficient subsea facilities are used to exploit deep water reserves.

The use of polymers in subsea application is growing continuously as they fit the requirement for materials that are adaptable to the dynamic subsea environment. The subsea developments are now in access of 3000 meters water depths with extreme challenging conditions [2]. Therefore, to maintain market edge, the oil/ gas producers are investing for increasing the operational thresholds for the thermomechanical performance of subsea systems. At such depths, the polymeric products are subjected to collapse or kinking due to high hydrostatic pressures.

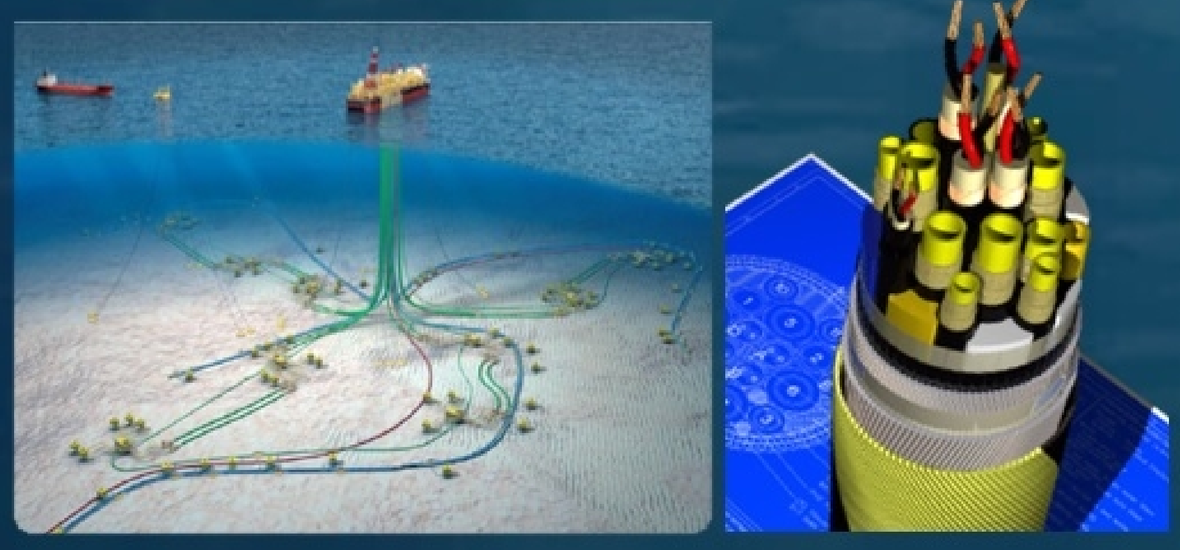

Fig 1 Subsea Control Systems

In this work, an advanced polymer used in subsea applications was engineered at molecular levels to improve its thermomechanical performance and thereafter subjected to testing. The current research used DMA to characterize the engineering polymer with focus on its mechanical behaviour and thermal properties.

Results and Discussion

All samples were extruded and tested with Perkin Elmer DMA 8000 at different temperatures (above room temperature).
Five test samples of dimensions; 30mm x 5mm x 0.7mm were cut from extruded strips. Creep samples were tested at 0.1N preload force and 2N step stress. Creep analysis (Fig 2) showed that sample deformation increased with temperature. However, insignificant plastic deformation was observed on recovery.

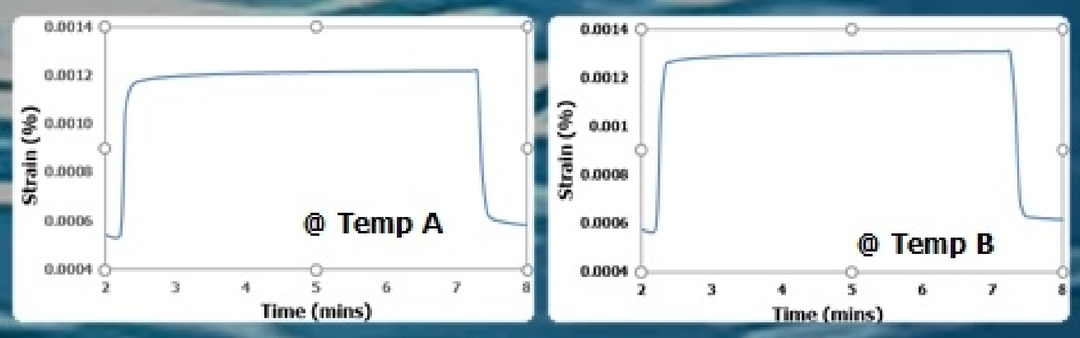

Fig 2 Creep-recovery curves at elevated temperatures. Temp B> A.

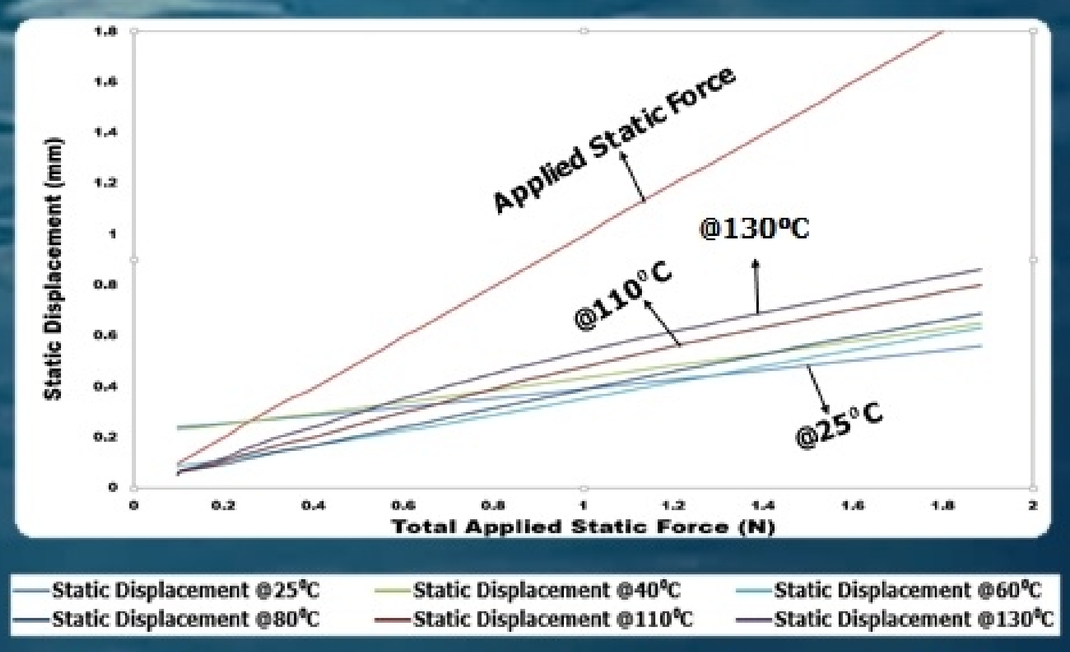

Fig 3 Force scan results (varied from 0.1N-2N)

The force scan (Fig 3) was used to compare the materials' stiffness at different temperatures from 25°C to 130°C. In this DMA mode, a range of force 0.1N-2N was applied to five samples of dimensions 30mm x 5mm x 0.5mm. The static displacement is related to strain and changes in the lines slope was observed for each temperature. It can be seen that at 110°C and 130°C, the material's modulus reduced slightly when compared to its stiffness at room temperature. This indicated that the storage modulus was reduced at elevated temperature.

Conclusion

Engineering materials at molecular scale is a key technique for modifying polymers' intrinsic physical properties including mechanical properties. This will allow the manufacturing of controlled polymer microstructures for improved performance such as collapse resistant tubes for ultra deep water applications.

References

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10bar 100m
30bar 300m
50bar 500m
80bar 800m
100bar 1000m
150bar 1500m
180bar 1800m
200bar 2000m
230bar 2300m
250bar 2500m
280bar 2800m
300bar 3000m
400bar 4000m
1bar = 10m

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