



Mechanical and Gas Transport Behavior of Dense Polymer Films

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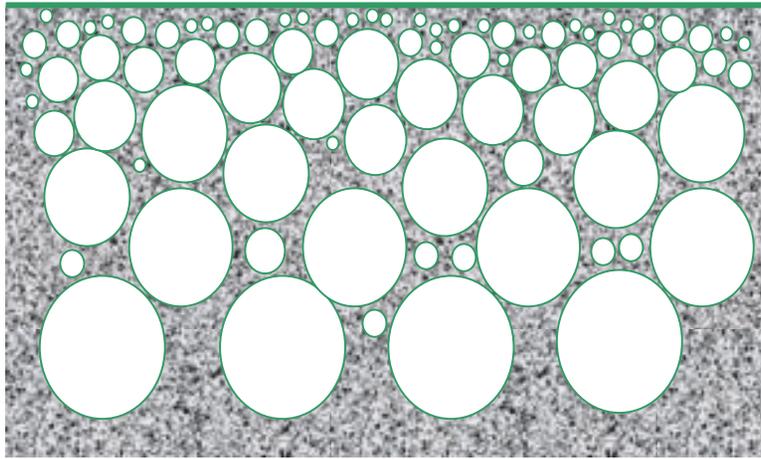


Macroscopic Considerations

- **Compaction: time-dependent compression (creep) of the membrane structure under an applied trans-membrane pressure.**
- **Compaction significantly contributes to flux decline in polymeric gas separation membranes.**
- **Elevated temperature separations lead to higher thermal efficiencies, but compaction can be significant and contribute to increased flux decline.**
- **Elevated temperature compaction measurement provides an assessment of membrane performance under more realistic and industrially relevant gas-separation conditions.**



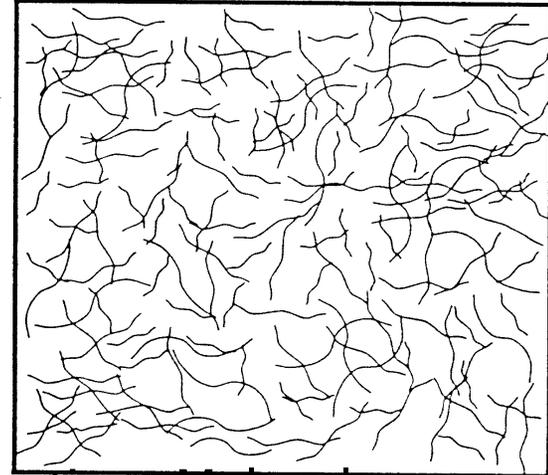
Microscopic Considerations



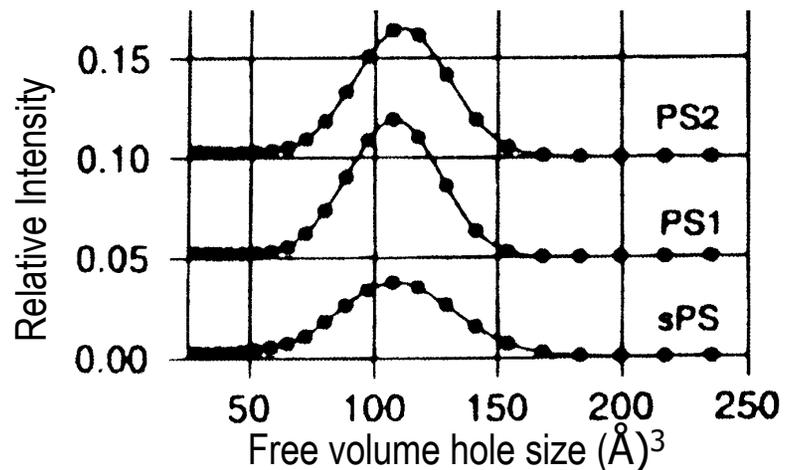
Schematic: Cross-section of an asymmetric and anisotropic polymeric gas separation membrane.

Free-volume hole size via positron annihilation lifetime spectroscopy (PALS) for PS; effective spherical hole radius is $\approx 3\text{\AA}$. Kobayashi et al (1992).

Dense layer

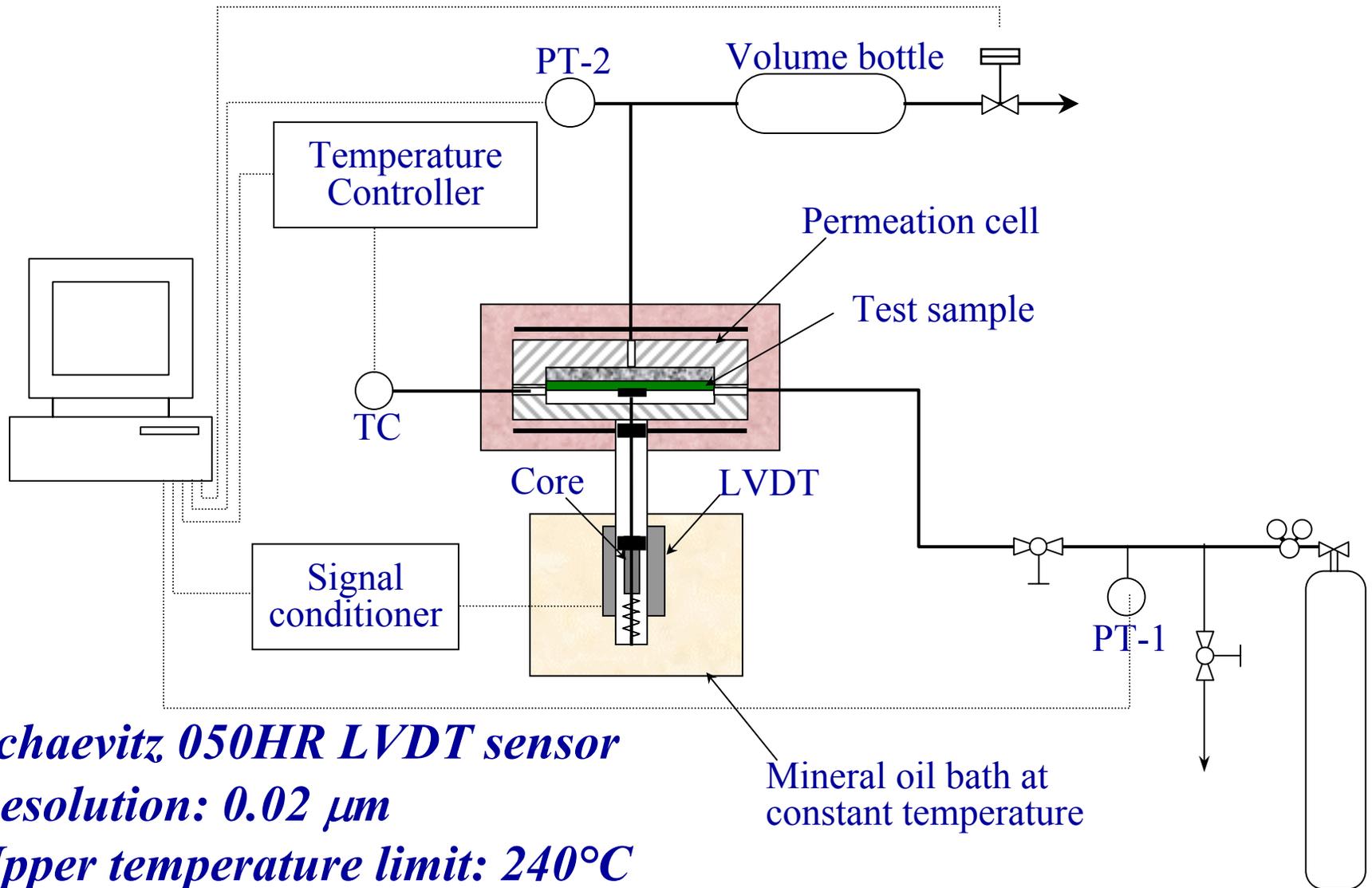


Schematic: Molecular arrangement in an amorphous dense film; occupied and free volume components. Freeman & Hill (1998).





Measurement



Schaevitz 050HR LVDT sensor

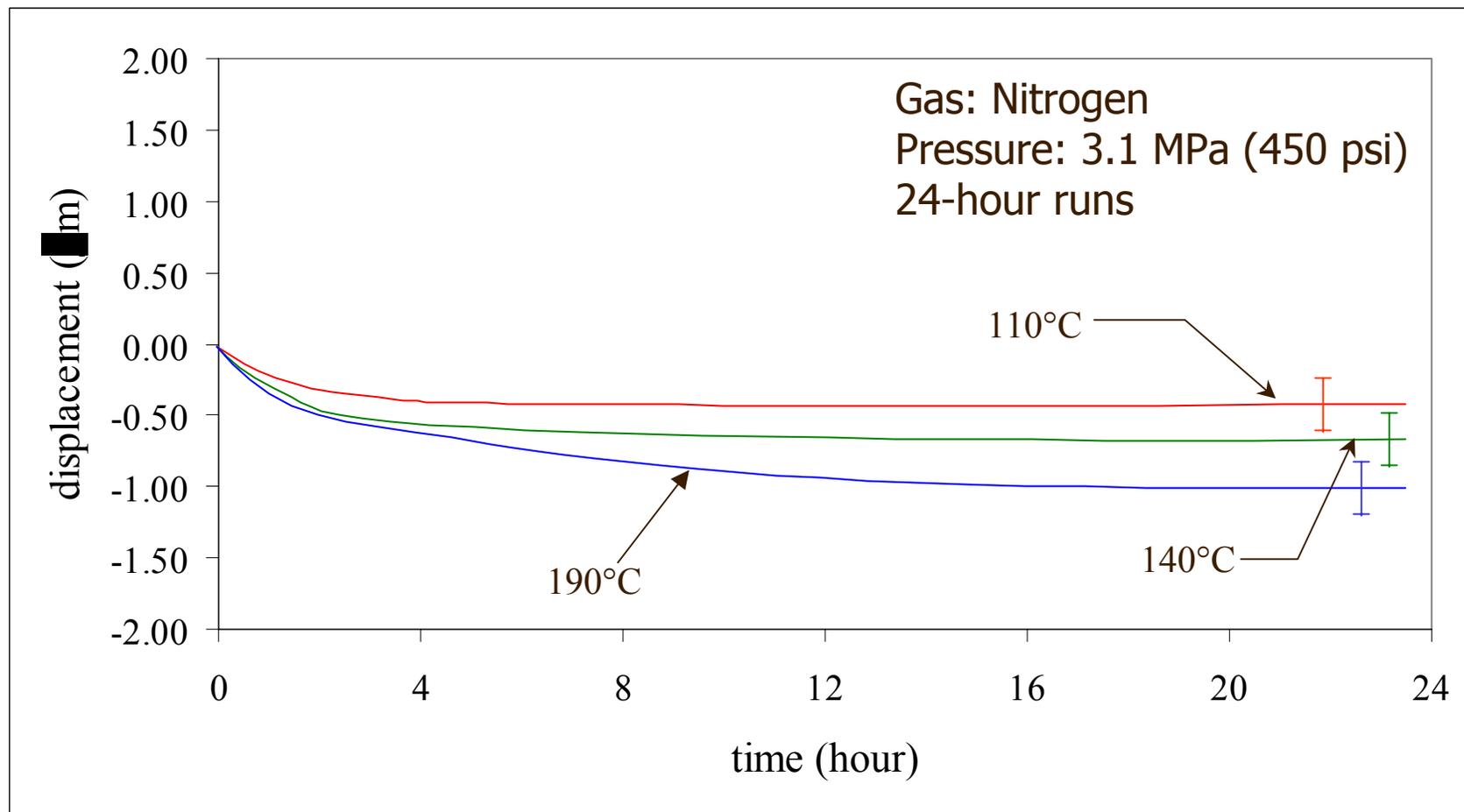
Resolution: 0.02 μm

Upper temperature limit: 240°C



Results: Mechanical

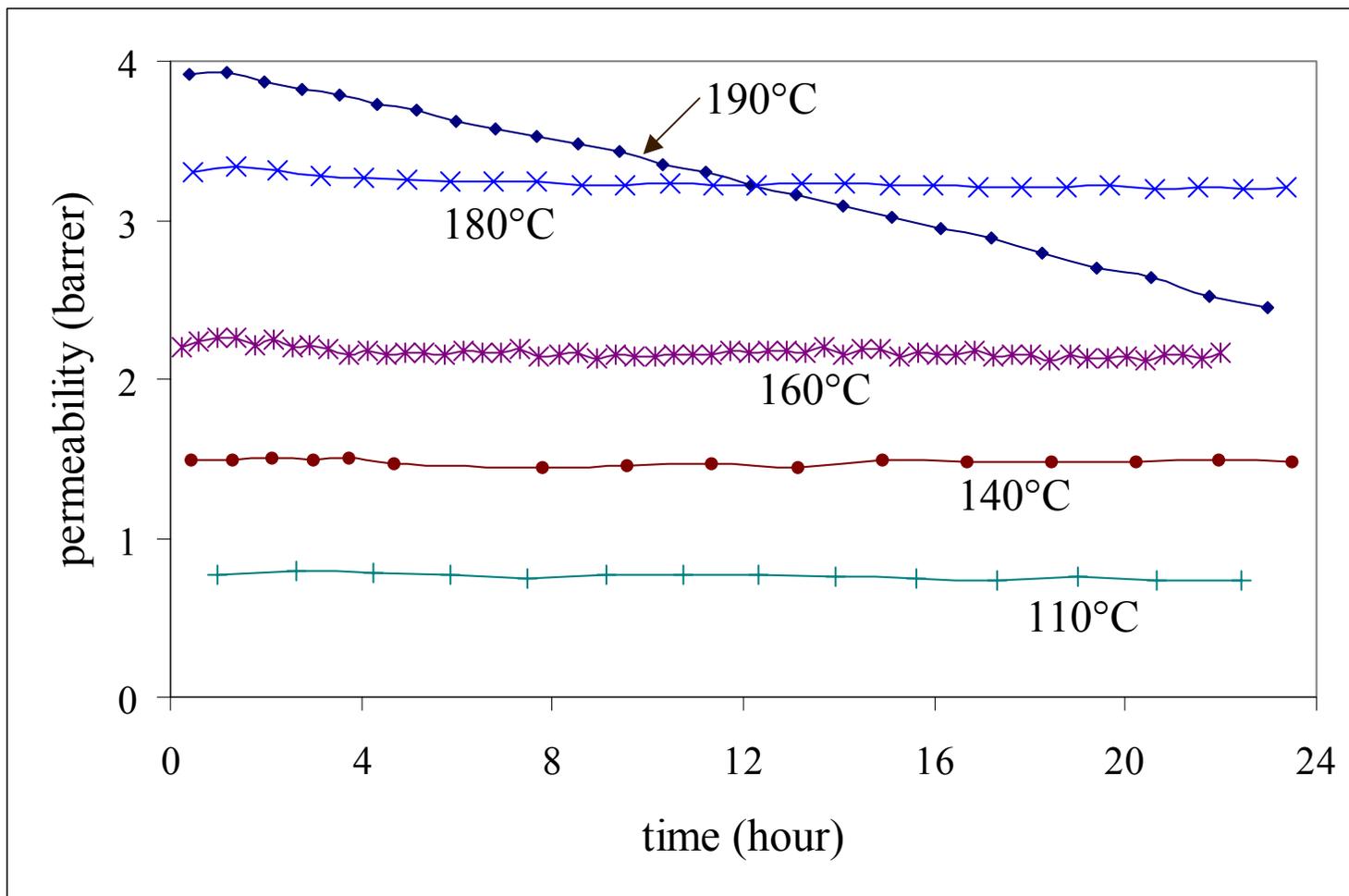
CA Dense Films in N₂





Results: Transport

CA Dense Films in N₂





Nanomaterials Metrology: Perspective

1. How does metrology affect your present work in nanomaterials?

Provides critical real-time information about simultaneous mechanical and transport responses.

2. What questions relating to reliability of nanomaterials would you hope to see addressed in this workshop and report/roadmap?

Is there a basis for extending short-term measurements to long-term performance?

3. What metrology issues are of the most significance to you for your work in the coming 5 to 10 years?

Integration of experimental and modeling approaches to predicting long-term performance.



Acknowledgement

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