# Influence of Supercritical $CO_2$ and $N_2$ on the Viscosity and Solidification Behavior of Polyethylene

J. Eckelt[1], M. Winkler[2], M. Walluch[2], D. Schwarz[2*]

[1]*Wee-Solve GmbH, Mainz, Germany*
[2]*Anton Paar GmbH, Graz, Austria*
[*]*daniela.schwarz@anton-paar.com*

The viscosity of polymer melts plays a critical role in processing efficiency, with high viscosities requiring increased energy input. Supercritical carbon dioxide ($scCO_2$) offers a promising approach to reduce melt viscosity without the need for solvent-based plasticizers [1]. In this study, the rheological behavior of different polyethylene (PE) types was investigated under elevated pressure using a plate-plate pressure cell capable of both rotational and oscillatory measurements.

Flow curves, frequency sweeps and temperature ramps were performed at ambient pressure, 120 bar $N_2$, and 120 bar $scCO_2$. While $N_2$ showed no significant impact on melt viscosity, it increased the solidification temperature, depending on the PE type. In contrast, $scCO_2$ acted as a temporary plasticizer, substantially lowering melt viscosity and slightly delaying crystallization. Oscillatory tests proved particularly useful for high-viscosity samples, enabling reliable measurements even near the melting point, provided strain and frequency were carefully adjusted.

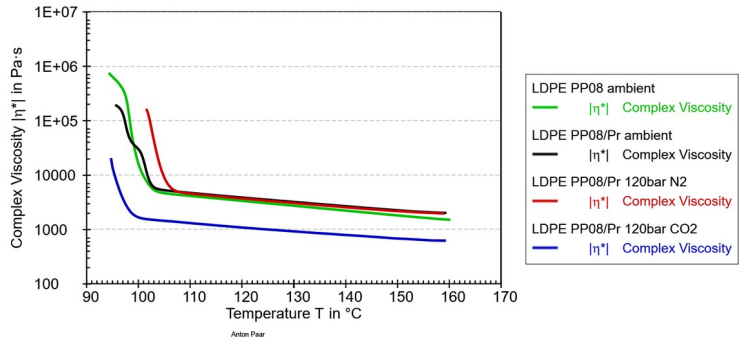


Figure 1: Temperature ramp in oscillation of LDPE at ambient conditions, 120 bar $N_2$ and 120 bar $CO_2$

The results highlight the potential of $scCO_2$ in energy-efficient polymer processing and foaming applications, and demonstrate the value of high-pressure rheometry for characterizing pressure-dependent polymer behavior.

**Keywords:** Polyethylene Viscosity, High-Pressure Rheology, Supercritical CO2, Polymer Crystallization, Plasticization with $CO_2$

## References

[1] Wan, C., Lu, Y., Liu, T., Zhao, L., & Yuan, W. Foaming of low density polyethylene with carbon dioxide based on its in situ crystallization behavior characterized by high-pressure rheometer. *Industrial & Engineering Chemistry Research* **2017**, 61(16), 5334-5345.