The importance of both physical aging and chemical weathering for the environmental fate of plastic

Calvin Carlson*†[1], Claudia Lorenz[1], Kristian Syberg[1], and Kristine Niss[1]

[1]Roskilde University (RUC) – Universitetsvej 1, P.O. Box 260DK-4000 Roskilde, Denmark

Abstract

Plastics, ubiquitous in modern society, undergo a complex aging process influenced by physical, chemical, and environmental factors. This work investigates the interplay between physical aging and enviro-chemical weathering in plastics and its implications for microplastic generation.
While chemical aging processes such as photo-oxidation have received significant attention for their part in environmental plastic degradation, the role of physical aging remains underexplored. This study addresses this gap by investigating the influence of physical aging on the overall outcomes of aging plastics.

Key research questions that will be addressed:

1) What role, if any, does physical aging play in the outcome of environmentally aged plastics?

Physical aging is an ever-present and unavoidable process affecting glassy plastics. Despite this, discussions on aging in plastics, particularly when discussing weathering and microplastic generation, revolve around chemical aging processes. Do these processes dominate in aging plastics? Does physical aging make any difference in the outcomes of aged plastics?

2) How does chemical aging and weathering affect the physical aging process?

Polymer chain scission, often due to photochemical processes, is regarded as the hallmark of chemical aging and weathering in plastics. The shortening of polymer chains also influences the glass transition temperature which has a direct effect on physical aging. A combination of experimental and computational methods can be used to investigate this connection and characterize the interplay between these processes.

3) How does physical aging affect the chemical aging process?

Physical aging plays an influential role in plastic production. Do plastics with different physical aging histories age differently once chemical aging processes are introduced?

*Speaker
†Corresponding author: calvinc@ruc.dk

This work will discuss the existing understanding of this field and provide considerations on future experimental work to elucidate and explore remaining uncertainties.

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