BRIDGE

2026

APPLICATION CASE STUDY

# UNDERSTANDING MATERIAL STABILITY USING ACCELERATED AGEING STUDIES

The Bridge Advanced Materials and Engineering R&D facility at the University of Lincoln enables companies to extend their in-house research and development capability by providing direct access to specialist equipment, facilities, and technical expertise. By using The Bridge as an extension of their own R&D function, organisations can accelerate innovation, de-risk development activities, and maximise return on investment in their people and projects.


## Concept

Accelerated ageing is a testing approach used to evaluate the long-term durability and performance of a material within a shortened timeframe by exposing it to intensified environmental conditions such as elevated temperature, humidity, ultraviolet (UV) radiation, mechanical stress, or chemical exposure. The objective is to simulate the degradation processes that would normally occur over months or years of service and predict the material's expected lifespan and reliability.

Material stability refers to a material's ability to maintain its physical, chemical, mechanical, and functional properties when subjected to environmental and operational conditions over time. By combining accelerated ageing studies with stability assessments, researchers can identify potential failure mechanisms, compare material formulations, validate product shelf life, and ensure that materials remain fit for their intended application throughout their service life. This is particularly important in industries such as pharmaceuticals, polymers, coatings, medical devices, and construction materials, where long-term performance and safety are critical.

## Accelerated Ageing – Theoretical Basis

For many materials, particularly polymers, reaction rates increase with temperature according to the Arrhenius relationship, which describes the temperature dependence of a chemical reaction. By exposing a material to elevated temperatures for a shorter period, it is therefore possible to estimate its long-term performance at normal operating temperatures.

A commonly referred to standard for accelerated ageing is ASTMF1980, which governs sterile barrier systems. Despite being directly developed for the medical device sector, the principles are now widely applied to other sectors too. The Arrhenius-based acceleration factor (AAF) is determined by the formula below:

$$\mathrm{AAF} = Q_{10}[\frac{T_{AA} - T_{RT}}{10}]$$

where $Q_{10}$ = a chemical rate actor, $T_{AA}$ = elevated temperature (e.g. 55°C,), $T_{RT}$ = ambient temperature (e.g. 20°C).

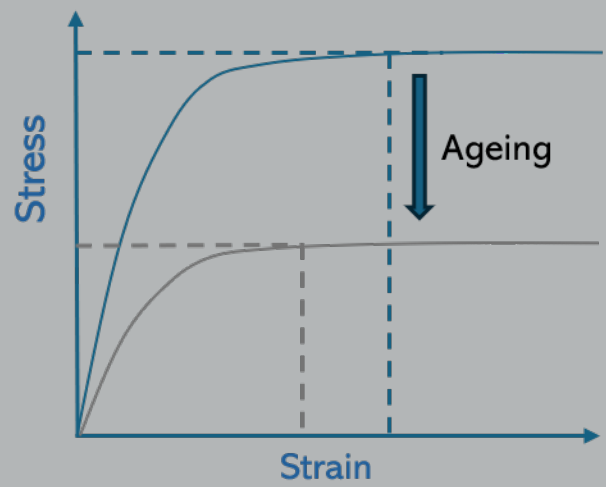
## Real World Benefits

Accelerated ageing testing provides a practical and efficient way to predict how a product will perform over its intended shelf life by exposing it to elevated environmental stresses such as temperature, humidity, light, or oxygen levels. By simulating months or years of natural ageing within a much shorter timeframe, manufacturers can estimate product shelf life, identify potential degradation mechanisms, verify packaging performance, and confirm that quality, safety, and functionality are maintained throughout storage and distribution. This enables faster product development and market launch, reduces the cost and time associated with long-term stability studies, supports regulatory submissions and labelling claims, and helps minimise the risk of premature product failure, customer complaints, product recalls, and unnecessary waste. Ultimately, accelerated ageing testing provides confidence that products will remain fit for purpose until the end of their stated shelf life.

# Accelerated Ageing at the Bridge

The Bridge has a range of accelerated ageing and environmental chambers to facilitate accelerated ageing studies under a wide variety of conditions such as varying humidity, UV and temperature.

Coupled to the Bridge's considerable downstream analytical capabilities, we can assess how products and packaging materials degrade over time in a variety of ways. For example, we can use mechanical techniques, such as dynamic mechanical analysis (DMA), can be used to investigate how the viscoelastic properties of solid materials change over time e.g. embrittlement. Alternatively, we can use our suite of chemical analytical techniques (chromatography mass spectrometry, NMR, X-ray diffraction etc.) to understand fundamental changes in materials with a view to future re-formulation strategies and enhanced material lifetimes.




BRIDGE

FUNDED BY

European Union
European Regional Development Fund

MIDLANDS ENGINE

UNIVERSITY OF LINCOLN

www.thebridge-lincoln.org

+44 (0) 1522 201 430

bridge@lincoln.ac.uk

Joseph Ruston Building
Edgewest Road
Lincoln, LN6 7EL