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PREDICTING MATERIAL-ENVIRONMENT INTERACTIONS VIA MODULAR APPROACH AND MULTISCALE MODELLING

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Abstract
Materials are impacted by environmental ageing. The uncertainty of the material-interaction compromises their superior properties and integrity, such as strength and stiffness. For biomaterials and sorbents, a desired service lifetime and adsorption rates and levels can be predicted. Validation of new materials often involves costly testing programs. Therefore, modelling is an affordable alternative that can partly replace extensive testing and thus reduce validation costs. Various approaches have been proposed to predict the long-term properties based on short-term measurements (in order to reduce time and involved costs).

In light of the increasing interest in biopolymers, a "two-edged sword" nature of the ageing phenomena is discussed. We have identified applications or which degradation is favourable (biodegradable plastics) and those for which it is unfavourable (structural polymers and composites). In conventional degradation, the objective is to retain the material within the useful lifetime, whereas, in biodegradation, the end of life is simulated. Therefore, the same ageing phenomena and modelling approaches would be applicable if the "decomposition" criteria replace the "safety" criteria.

This review offers a systematised overview of the state-of-the-art models and accelerated testing methodologies. Service lifetimes are predicted by means of degradation rate models, superposition principles, and parametrisation techniques.

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