EDITORIAL OPEN

Standing the test of time

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If one were to travel back only a few thousand years—a small period in the lifetime of our planet—the materials in use would be very different to those we utilise today. We owe our present lifestyles, including air travel, computer processing, medical implants, and energy generation, to advances in our ability to understand and engineer materials. These materials, which also served as pillars of the industrial revolution in the 1700s and 1800s, are man-made, yet utilise nature's palette of elements: a finite list of cooking ingredients, one might say. In the so-called natural state, most elements are bound with other elements, be it metals with other metals, or in the form of oxides, carbonates, etc. Such natural forms, whilst apparently stable, have been evolving over millions of years. In nature everything continuously evolves, transforms, changes—challenging the notion that equilibrium ever exists-and the physical, chemical and biological processes at play are generally slow when compared to the time scales most humans are familiar with.

The question of degradation is pressing in the case of man-made materials. For example, to create most of the metals we employ as engineering materials (i.e., steels, aluminium, nickel, copper, platinum, etc.) significant amounts of energy are needed to cheat the natural state in which metal atoms are originally found. The recovery of such energy by nature is a constant driving force for degradation of the man-made state. Moreover, the same is true of glasses, ceramics, polymers, concrete and essentially any other organic or inorganic material that has been produced by man. Whilst such an introductory statement may sound dated, well-known, and too poetic for a scientific journal in the 21st century, it serves as a reminder of the simple fact that we are nowadays pushing materials to their limits, and will continue to do so at an accelerated rate. Philosophically, degradation is a man-made concept tied to a performance goal, or to a set of target properties assigned to a material over a given period of time. It generally convolutes economic and technical aspects in relation to a given application. As a result, a focus on materials degradation, in numerous situations and applications, is increasingly timely.

The importance of understanding and controlling materials degradation needs no elaboration, and the reliability and durability of materials is essential to the safeguarding of life (consider a bridge, an aircraft, or radioactive waste stored in a subterranean repository). Indeed, studies on the cost of corrosion (corrosion being only one portion, albeit a major one, of materials degradation) indicate that it costs society a substantial amount of money: a paper in this journal puts the figure at approximately $310 billion in China in 2014 (3.34% of GDP).[1] As well as money lost, equally worrisome is the thought that such funds could be better spent on other key sectors, including social benefits, healthcare or infrastructure development, to name a few. It is concerning that in the face of repeated studies separated by years and decades—for degradation and corrosion are not new phenomena—the same issues still arise all over the world. This means that the lessons learnt in regards to materials degradation are not being fully appreciated by engineers, scientists, corporations, policy makers or the general public. Much of the materials degradation we observe is avoidable, but the implementation of degradation control and management requires education.

It is always hard to predict the future, but, several factors in the materials field are assured. Firstly, the time-to-market for consumer products, and time for national projects in some cases, is becoming shorter. This means that materials are being inserted into more demanding (often untested) applications, and also into more extreme environments (such as nuclear waste disposal). These factors mean that the durability of materials will continue to be an important challenge that scientists and engineers must work to overcome.

Secondly, the tools used to study materials degradation are rapidly evolving. These days, electron microscopy is commonplace in most laboratories, in addition to 3D surface analysis methods, and nearly all forms of spectroscopy can nowadays be portable (and hence, purchased reasonably cheaply), such as Raman and X-ray fluorescence. We have the power to study things like never before, and that power is growing at a rapid rate. Advanced analytical techniques, such as atom probe tomography, nano-secondary ion mass spectrometry, cryo-transmission electron microscopy, including the clever design of in situ and non-destructive experiments, are undoubtedly opening new insights into the fundamental understanding of materials degradation. Aside from empirical tools, advances in computation, from first principles modelling to multi-scale modelling, to life prediction for long term durability, are all rapidly evolving too.

The time is here when materials degradation is a significant and exciting discipline. The reason for this is that with each day that passes, the amount of resources diminish and wastage is not acceptable in modern society. We are approaching the point—if not past it—where conservation will be more important than consumption; that is an important step for our planet, and for future generations of its inhabitants. Understanding the fundamental science behind degradation of materials and how we prevent it are vital now more than ever.

We encourage all our colleagues working on materials degradation, here taken in the broadest possible sense, to submit their most important results, reviews and discussion-pieces to our new journal. The journal accepts contributions in many formats, including full length original works, commentaries, viewpoints, and industry insights. The journal seeks to disseminate outstanding work on any kind of materials (natural or manufactured) undergoing transformations accompanied with a loss of the initial or targeted properties. This includes fundamental and applied research on metals, ceramics, glasses, polymers and all kinds of hybrid materials. High quality studies relating to lifetime prediction, thermodynamic and kinetic aspects, protective coatings, surface, interface and interphase issues, effect of intrinsic or extrinsic parameters, performed on the basis of experimental, modelling or theoretical approaches, will all find a home in *npj Materials Degradation*. Our editorial team is diverse, composed of researchers active in the field, and which seeks to grow with the

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maturity of the subject. We represent wide geographic and gender balance and seek to be a positive alternative and consolidated home for areas not previously well represented for researchers who wish to publish their most important findings in materials degradation.

npj Materials Degradation seeks to push the boundaries of the field, with agility, flexibility, a focus on dynamic fields, and to spread these messages via its policy of wide dissemination by Open Access. The science (just like nature's palette of elements) belongs to everyone.

ADDITIONAL INFORMATION

Competing interests: The authors declare that they have no competing financial interests.

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N. Birbilis[1] and S. Gin[2]
[1]Department of Materials Science and Engineering, Monash University, Clayton, VIC 3800, Australia and [2]French Atomic Energies and Alternatives Energy Commission (CEA), DEN—Marcoule, F-30207 Bagnols-sur-Cèze Cedex, France
Correspondence: N. Birbilis (nick.birbilis@monash.edu) or S. Gin (stephane.gin@cea.fr)

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