Still going strong

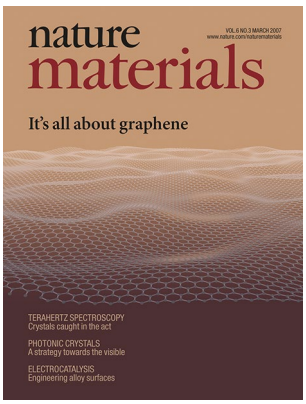
As *Nature Materials* turns 20 we look back at how materials science has evolved and consider future directions.

Time certainly flies but the original decision to pick materials science for the first Nature research title in the physical sciences was clearly the right choice. Much has changed since then, but what remains true is that materials research is still one of the most exciting, innovative and frontier disciplines in interdisciplinary science and technology.

Recent evolution in this ever-expanding field can be viewed in many different ways, but the structure and composition of materials will always remain essential for understanding their properties and designing functional devices. Microscopy techniques based on electrons and X-ray photons have experienced major advances in terms of both spatial resolution and sensitivity to composition and physical properties. Examples include the advent of aberration correction to image single atoms or three-dimensional (3D) electron tomography and holography; the implementation of high-brightness synchrotron radiation sources leading to the development of extremely sensitive X-ray techniques; or with free-electron lasers, the capability to investigate the dynamics of molecules on the femtosecond timescale. New generations of spallation sources have also led to higher-power beams, allowing materials to be probed at shorter length scales and with greater sensitivity.

Increases in both computing power and algorithms have enabled larger and more efficient simulations, while machine learning can now be used to perform more accurate simulations, or to extract correlations in large datasets. Materials discovery for specific applications involving considerations of performance, stability, cost, manufacturability, availability, toxicity and sustainability has increasingly been reliant on these techniques. Advances in materials synthesis and fabrication have enabled substantial improvements in functional materials properties for applications such as photovoltaics, solar fuels and water-splitting, fuel cells or thermoelectrics. Materials with unprecedented properties such as graphene (pictured) and 2D materials, metamaterials, perovskites and metal–organic frameworks have emerged and continue to generate much interest across many disciplines.

To celebrate our anniversary, we asked experts to explore progress in their research areas but also to speculate on how to address the grand societal challenges associated



with information technologies, energy and sustainability, mobility, urban living and health. Philip Ball, our Materials Witness columnist, also provides his perspective on materials innovations and their cultural and societal significance. Indeed, all of these cutting-edge developments have complex and uncertain implications for society, culture and governance.

Evolution can be seen as a march towards stronger, tougher, more versatile structural materials with advances for composites and new materials such as high-entropy alloys, bioinspired materials and heterostructured materials. Through the lens of information technologies, innovations in microelectronics and optical materials have radically transformed our lives and societies. Spintronics has evolved towards lower power, faster and more stable operation, while topology has revolutionized the study of quantum materials, with advances in multiferroic and correlated electron materials. For sustainable technologies, advances have been made in the ability to store electric charges on surfaces and/or through redox processes and in the design of novel materials to develop better device performances or new batteries beyond Li-ion batteries, such as Na-ion or all-solid-state batteries. For organic semiconductor light-emitting diodes and photovoltaics, it will be crucial to engineer the spin exchange energy and designs that reduce multi-phonon decay and low-lying dark triplet states. Novel biomedical materials and soft matter have enabled the ability to shape and engineer living tissues and biological responses, offering new possibilities in healthcare. An obvious example is the development of lipid nanoparticles for mRNA delivery, which culminated in the COVID-19 mRNA vaccines.

From the publishing perspective, the increasing number of scientific articles in the natural sciences (mostly driven by expanding research capacities in fast developing countries such as China) published in new journals is particularly striking. Simultaneously, increasing open-access awareness and mandates has had a significant impact on publishing models traditionally based on subscriptions. As a result, transformative journals, such as *Nature Materials*, now allow authors to publish their research through the traditional route or to make their paper immediately open access by paying an article-processing charge. To increase the transparency of author contributions and to enhance the accessibility of data and code, our online paper formats have also evolved.

Finally, we would like to thank all of the generations of editors that have contributed to the success of the journal with their enthusiasm and dedication. Some are now chief editors or in managerial positions within Springer Nature or with other publishers. Others have gone back to academia or have even joined start-ups. *Nature Materials* has always been committed to publishing the most influential and intellectually stimulating multidisciplinary research, to improving our services, and to providing a lively forum in which scientists from very different backgrounds can come together and exchange ideas. Wherever materials and publishing may take us, we will continue to evolve and maintain our editorial independence, high standards and balanced approach to the broad field of materials research. Then, and now, we are only too aware that the success of the journal is primarily due to all of our authors, reviewers and readers. Our ultimate goal is to serve the community and to provide a vehicle to reflect the increasing importance of materials to improve our standard of living and health within a framework of sustainable development.

Climate change and recent events such as the COVID-19 pandemic and the Russian invasion of Ukraine have been affecting our collective well-being. Like the world around us, materials science is constantly evolving, and our commitment to the community remains undimmed. As the cornerstone of the fastest-growing technologies, materials have a bright future to ensure global economic growth and societal developments. ❐

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