Curiosity calls

Decades can pass from the discovery of a molecule or material to its commercial use and often the eventual application differs from the use initially envisaged by the curious researcher.

The potential application of molecules and materials is commonly the focus of research grant proposals and the ultimate aim of research projects. But in practice, the journey starting from an initial chemical synthesis to a technological application is an unpredictable route.

In a Perspective in this issue, Cheetham et al. consider this journey from chemical synthesis to the technological breakthrough while also highlighting if and when the discovery was recognized by a major prize. Three possible routes — each outlined with representative examples — are described in the Perspective. First, a molecule or material for a specific function can be devised from design principles identified in a previous synthesis. Second, a use or a certain property that leads to an application may be discovered by chance, however, these serendipitous discoveries are rare. Third, and suggested in the Perspective to be the most prevalent, the eventual application of a molecule or material appears (sometimes decades) after the synthetic breakthrough and, in some cases, is not the same as the use initially envisaged for it. These molecules or materials may have been originally made out of curiosity or intended for one particular application and then repurposed for a completely different one.

One example given is C_{60}, the allotrope of carbon discovered almost half a century ago that, although undoubtedly an important discovery, has only been used in a few technologies. However, the curiosity-driven research that followed from the discovery of C_{60} led to a wealth of new carbon nanomaterials more generally. Cheetham et al. also comment on the rich materials discoveries when well-studied bulk materials are made at the nanoscale, such as graphene and quantum dots. Coincidently, an Article by Segawa et al. in this issue reports the synthesis of a twisted armchair fragment of a carbon nanotube, namely, a Möbius carbon nanobelt.

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The Möbius structure (pictured) has fascinated mathematicians, artists, musicians and historians over the centuries and it's not the first time a molecular Möbius structure has been prepared. However, molecular Möbius structures are few and far between[1,2] because of their instability compared with untwisted analogues resulting from high strain energies, as highlighted by Price and Jasti in a News & Views in this issue. The fully-fused Möbius nanobelt reported by Segawa et al. is prepared by using a bottom-up approach in which the aromatic carbon chain is formed by sequential Wittig reactions and all of the carbon atoms it contains are sp^2 hybridized.

The Möbius carbon nanobelt can twist in either a clockwise or an anti-clockwise direction and, as a result, two enantiomers form that can be separated by chiral high-performance liquid chromatography. Although preliminary photophysical results are reported, indicating a greenish-blue fluorescence for the Möbius carbon nanobelt, there is much more to be explored for this topologically intriguing structure. On the macroscale, Möbius belts have been used as drive belts in machinery for two centuries, pre-dating the naming of the twisted strip as the Möbius strip[3]. Although there is no clear correlation from the macroscale to the nanoscale in this case, the long history of Möbius structures and the curiosity they generate makes this carbon-based nanobelt an inspiring synthetic discovery. Perhaps it will be possible to make related molecules using similar processes and these structures may prove useful (potentially several decades in the future) for applications well beyond our current knowledge and expectations.

Although the observations made by Cheetham et al. suggest that materials discoveries benefit from either curiosity-driven research or scientists re-purposing materials gathering dust on laboratory shelves, the reality from a funding point-of-view is quite different. But in a dream world, for some of us, it's refreshing to know that fundamental research stemming from our curiosity serves a purpose and is a driver of practical innovation in research. ❐

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