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Editorial

Shedding light on protean matter

In Greek mythology, the sea god Proteus was both an oracle and a shape-shifter. Those who wanted to question this "Old Man of the Sea" first had to restrain him as he changed between his many different forms [1]. Like Proteus, photochromic molecules, with their ability to undergo light-triggered switching, are shape-changers *par excellence*. For this reason, these systems have proven themselves invaluable in a broad array of applications. This special issue is dedicated to the discussion of these endlessly fascinating protean molecules and the many uses to which they have been put.

This project grew out of the 5th International Symposium on Photochromism (ISOP-07), which was held in Vancouver, BC, in October 2007. ISOP-07 brought together researchers from around the world to report on the latest advances in light-switchable molecules, with topics that ranged from fundamental studies of photochemical processes, to the synthesis of new chromophores, to the exploitation of these systems in materials and biological applications. The excitement generated by that conference inspired us to assemble this collection of papers, all of which were contributed by participants at the symposium. These papers include both original research contributions as well as several short reviews in selected areas. Together, these papers provide a cross-section of a diverse and vibrant field.

The study of photochromic molecules is by no means a new discipline; its genesis dates to 1867 and Fritsch's observation of the photodimerization of tetracene [2]. Although photochromism is a relatively mature field, it is one that has maintained a youthful vitality, and interest in photochromic systems has been on the rise over the past decade. A search of SciFinder indicates that in 2007 there were 585 papers and 222 patents that contained the keywords "photochromic", "photochromism" or "photoswitch [3]." These numbers represent a conservative estimate of the ongoing research that is being carried out in the area, as a large number of other reports do not employ these terms yet describe research in which photochromic processes are exploited.

Why this burgeoning interest in photochromism, even after 140 years? There are several factors at work, all of which are evident in the papers appearing in this issue. Perhaps most significantly, there is a growing appreciation for the versatility of these molecular switches. Photochromic materials have long been used as coatings for ophthalmic lenses, and traditionally much of the basic research in the area has been driven by the demands of that industry, which requires materials with good switching times, thermal stabilities and fatigue resistance. While the color-changing properties of photochromic systems will undoubtedly remain the cornerstone of the field for some time to come, researchers are increasingly turning their attention to the changes in shape, electronic properties and chemical reactivity that also accompany these light-induced transformations. This change in emphasis provides new opportunities for designing truly novel smart materials, such as objects that can alter their shape at the macroscopic level [4], to cite just one example of many.

The application of photochromism to biological systems is also a direction of emerging importance. Photochromic molecules have long been exploited in the context of materials applications, but their use in bio-related research has been slower to develop. This disparity is somewhat surprising, especially since two of the most striking examples of photochromism are the photoisomerization of rhodopsin, which is crucial for vision, and the formation of thymine dimers, which is associated with skin cancer. While biological applications of photochromic systems have largely been overlooked in the past, there are strong indications that this is changing; an ever-increasing number of manuscripts have appeared within this area and a full session of ISOP-07 was dedicated to such systems.

The methods that are used to probe photochromic systems are continually improving, which is another reason why research into these elusive molecules is on the rise. Just as Proteus's shape-changing abilities made him difficult to question, the investigation of photochromic molecules has often been greatly complicated by their mutability. Several manuscripts in this issue address this challenge, either via the application of instrumental techniques or by theoretical modeling. Such studies reveal the complexity that is often involved in even "simple" photochromic processes.

Molecular diversity was another key theme at ISOP-07, and it is one that figures prominently in this special issue. Photochromism manifests itself across broad classes of compounds that include both organic and inorganic systems. It can involve unimolecular electrocyclization or *cis*–*trans* isomerization reactions, or bimolecular dimerization processes. The reactions can occur in solution, within polymer matrices or in crystalline solids. These transformations may be largely insensitive to the chemical environment, or may be significantly perturbed by the solvent or other chemical species. The changes in molecular structure may be rather modest, or may involve large changes in atomic coordinates and charge distributions. The products may be stable over long periods of time, or may revert quickly to their starting materials. Because each application has its own unique set of requirements, the wide range of options available should be regarded as a positive attribute.

Where is the field of photochromism heading? This is a question that perhaps could be posed to the oracular Proteus, but ultimately will only be illuminated in the fullness of time. What is clear is that

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this is an area that, like photochromic molecules themselves, will be continually changing.

References

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