Synthesis and Characterization of Teranthene: A Singlet Biradical Polycylcic Aromatic Hydrocarbon Having Kekulé Structures

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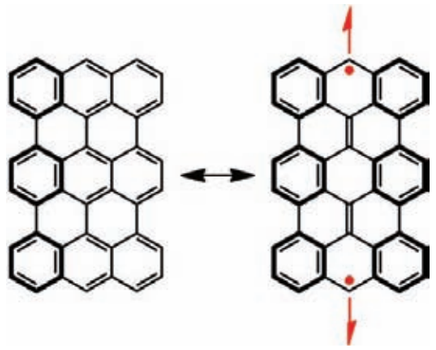
We have demonstrated the uncoupling of the electron pair in a Kekulé polycyclic aromatic hydrocarbon (PAH), the extent of which being governed by the energy balance between the formal loss of the double bond and the aromatic sextets formation. Our study further shows that the singlet biradical character in PAHs can be investigated experimentally in an unexpectedly small-size molecule. This finding would encourage a bottom-up approach for establishing spintronics and nonlinear optics, both based on molecular-size nanographene compounds.



Bivalent Inhibitors for Disrupting Protein Surface-Substrate Interactions and for Dual Inhibition of Protein Prenyltransferases

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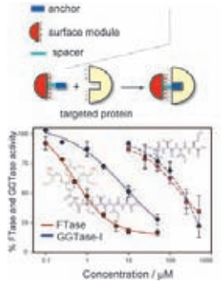
Journal of The American Chemical Society, **133,** 958-963 (2011)

Low-molecular weight compounds that disrupt protein-protein interactions (PPIs) have tremendous potential applications for investigating PPI networks, however, designing such compounds still remains difficult due to the flat protein interfaces. We reported a new strategy for designing bivalent enzyme inhibitors that anchor to the active site and deliver a minimally sized module to the targeted surface involved in PPI with a substrate. Inhibitors of FTase, derived by linking a gallate derivative to a CVIM tetrapeptide, show remarkably improved inhibitory activity against FTase compared to the CVIM. Furthermore, the compounds also inhibit GGTase I, which is composed of the identical α-subunit to that of FTase. This is the first example demonstrating that common structural features on protein surfaces can be vulnerable for PPI inhibitors as well as dual inhibitors of structurally related enzymes.



Synthetic Organic Spin Chemistry for Structurally Well-defined Open-shell Graphene Fragments

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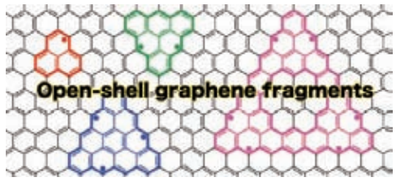
Nature Chemistry, **3,** 197-204 (2011)

Three benzene rings can be fused in three different ways to yield linear anthracene, angular phenanthrene, and triangular phenalenyl. The former two structures are drawn as closed shell structures, while the latter one is only drawn as open-shell structure. These three kinds of benzene derivatives are designed by clipping from graphene known as a planar sheet-like gigantic π-electronic system. Triangular clipping from graphene similar to the phenalenyl structure leads to an entire family of "open shell graphene fragments" which are of substantial interest, from the standpoints of fundamental science as well as their potential applications in materials chemistry. We discuss current trends and challenges in this field.



Large Bulk Resistivity and Surface Quantum Oscillations in the Topological Insulator Bi_2Te_2Se

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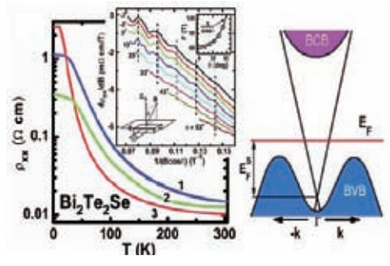
Physical Review B, **82,** 241306(R) (2010)

The topological insulator is a novel quantum state of matter that is supposed to show insulating behavior in the bulk and spin-filtered metallic conduction on the surface. In practice, however, most of the known topological-insulator materials are poorly insulating in the bulk, hindering the transport studies of the topological surface state. We have synthesized a new topological insulator, Bi_2Te_2Se, which approaches insulating behavior in the bulk for the first time in this class of materials. Moreover, we observed clear Shubnikov-de Haas oscillations coming from the topological surface state, paving the way for exploiting the unique surface conduction properties of topological insulators.



Zero-doping State and Electron–hole Asymmetry in an Ambipolar Cuprate

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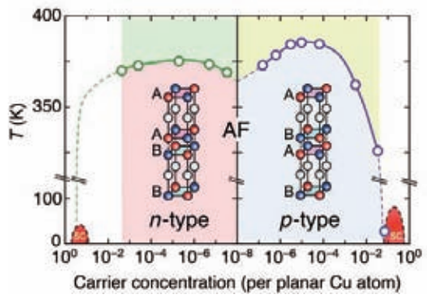
Nature Physics, **6,** 579-583 (2010)

High-temperature superconductivity occurs when a sufficient number of charge carriers are doped into a parent cuprate Mott insulator. In order to clarify the mechanism, it was desirable to study what happens when a small number of electrons are either added or removed from the Mott-insulating state. Yet, until recently, there were no examples of a single Mott insulating material where both *n*-type and *p*-type doping are realized. We have synthesized a unique cuprate material $Y_{1-z}La_zBa_{2-x}La_xCuO_y$ and found intriguing results at very low doping levels, where a marked difference in properties of electron- and hole-doped materials is manifest.



The Prominent 5d-orbital Contribution to the Conduction Electrons in Gold

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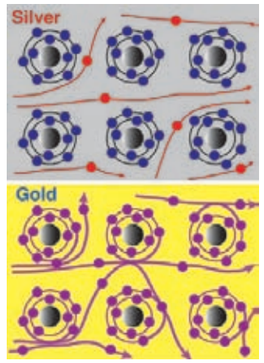
New Journal of Physics, **12,** 043045 (2010)

Single-element materials in the same column in the periodic table often show mutually similar features. However, it is known for noble metals that gold has considerably different chemical stability from that of silver. We have examined their electronic structures by the synchrotron radiation-based photoemission we have developed. Contrary to the ordinary expectation, it is found that the 5d-orbital electrons contribute prominently to the conduction electrons in gold while the conduction electrons in silver are free-electron-like with negligible 4d contribution as schematically illustrated in the figure. This finding could be related to a well-known fact that gold is more stable than silver in air.



Far-Infrared Interferometric Telescope Experiment (FITE):Three-Axis Stabilized Attitude Control System

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Transactions of the Japan Society for Aeronautical and Space Sciences, Aerospace Technology Japan, **8 (ists27),** Tm_19-Tm_24, (2010)

We have developed a far-infrared balloon-borne interferometeric telescope (FITE). The goal of this project is to achieve a very high spatial resolution (1 second of arc) for electromagnetic waves at around 3 THz frequency. This telescope must be flown up to at least 30,000 m of altitude because the atmosphere of the earth is almost opaque for the far-infrared radiation. In order to meet this requirement, we adopted a three-axis attitude control system for a balloon-borne telescope (as for a satellite on orbit in space), and achieved high control accuracy enough to resolve fine structures of important astronomical objects, such as protoplanetary disks where planets are born.

Miniaturized High-Resolution Time-of-flight Mass Spectrometer MULTUM-S II with an Infinite Flight Path

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Analytical Chemistry, **83,**8456-8463 (2010)

Recently, development of miniature mass spectrometers has been at the forefront of research in mass spectrometry. Mass resolution is generally proportional to the size of instruments, so that high mass resolution cannot in principle be obtained by miniaturized instruments. However, we developed unconventional instrument using time-of-flight technology. The developed system is "MULTUM-S II" and the mass resolution is tunable by changing the flight length (number of cycle). In this paper, obtained mass resolution was 30,000, and CO_2 and N_2O doublet was clearly separated. This result indicates that this system is feasible for an on-site greenhouse gas monitoring.