

PHYSICS

Möbius inversion and Chapman-Enskog expansion for solving the Boltzmann equation

The Chapman-Enskog expansion for the Boltzmann equation is divergent or indeterminate when the perturbation parameter is greater than '1', which has puzzled this subject for a century. Recently, Nan-Xian Chen from Tsinghua University in China and Bohua Sun from the Cape Peninsula University of Technology in South Africa propose a modified Chapman-Enskog expansion with a variable upper limit of the summation by using a modified Möbius series inversion formula. The new expansion can not only give a convergent summation, but also provide the best explanation so far on some unbelievable scenarios that occurred in previous practice. The research may have the much broader impact on well-known perturbation methods in general.

[Chen NX *et al. Chin Phys Lett* 2017; 34: 020502]

CHEMISTRY

'Bottom-up' synthesis of N-doped graphene as an active metal-free electrocatalyst for oxygen-reduction reaction

Synthesis of N-doped graphene (NG) by the conventional approach from graphite is not satisfactory, either employing time-consuming steps or introducing transition metal impurities. Recently, joint research of Qian Liu, Jianjun Liu and Jiacheng Wang at Shanghai Institute of Ceramics, CAS, and co-workers described a facile and 'clean' 'bottom-up' process to prepare NG (see Fig. 1). Annealing of NG (NG-A) promoted the conversion of pyrrolic-N to pyridinic-N, responsible for high oxygen-reduction activity in

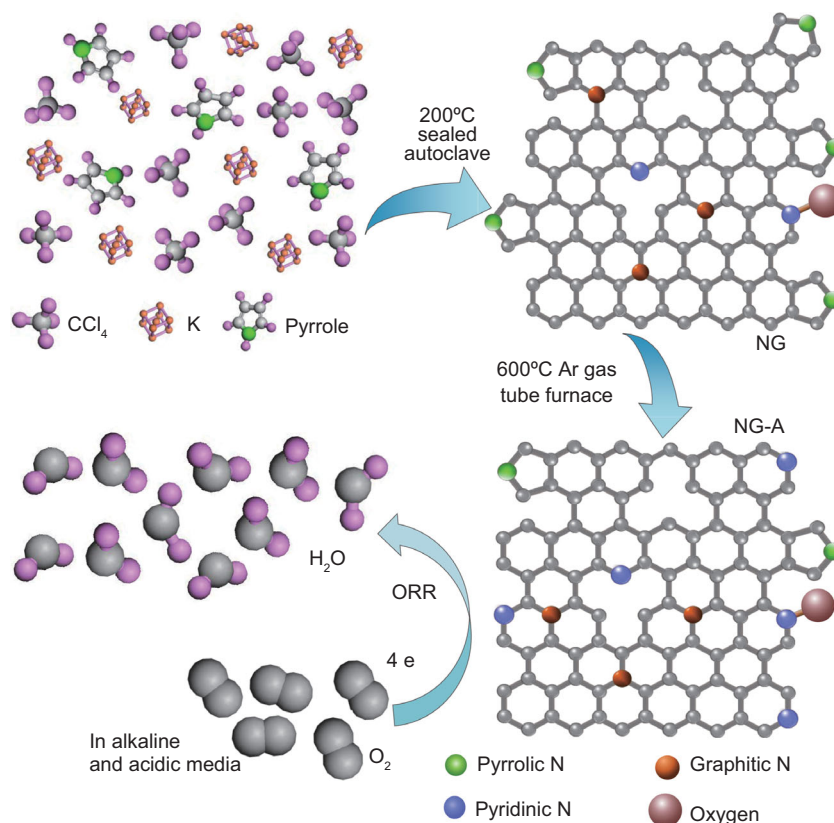


Figure 1. 'Bottom-up' synthesis of N-doped graphene (NG) and its annealed sample (NG-A) for efficient oxygen reduction.

alkaline and acidic media. This research contributes to the synthetic methodology of NG and also promotes further understanding of the catalytic mechanism of NG.

[Ma R *et al. Nano Res* 2016; 9: 808–19]

CHEMISTRY

Understanding CO₂ hydrogenation by thermodynamic analysis

The exploration of CO₂ hydrogenation into valuable products has been carried out over enormous catalysts, the opti-

mization of which essentially depends on the theoretical understanding of the reaction. Yanhui Yang's group at Nanyang Technological University in Singapore conducted thermodynamic analysis for CO₂ hydrogenation into CO, carboxylic acids, aldehydes, alcohols and hydrocarbons by the Gibbs energy-minimization method. Particularly, a multiple products system was investigated, which shed light on the tailoring of reaction conditions, such as temperature, pressure and reactant ratio, to maximize the conversion and selectivity for large-scale commercialization.

[Jia C *et al. J Energ Chem* 2016; 25: 1027–37]

CHEMISTRY

Production of 1,3-propanediol from the non-petrochemical route

1,3-propanediol (1,3-PDO) is an important building block in the polyester industry. Selective hydrogenation of syngas-based or biomass-based diester, such as diethyl malonate (DEM), to produce 1,3-PDO is a promising route that suits for the energy-structure feature of China. However, the selectivity to 1,3-PDO is unsatisfactory. Linmin Ye, Youzhu Yuan and co-workers from Xiamen University reported the hydrogenation of DEM to 1,3-PDO with a yield of 90% over a bimetallic Cu–Fe/SiO₂ catalyst. The excellent catalytic performance is mainly due to the synergistic effect of Cu⁰ and FeO_x species. The study provides an alternative for the production of 1,3-PDO.

[He L *et al. J Energ Chem* 2016; **25**: 1038–44]

BIOLOGY & BIOCHEMISTRY

Cryo-EM structure of human mTOR complex 1 at 4.4 Å resolution

mTOR complex 1 (mTORC1) is one of the most critical regulators for cell growth and an important target for cancer therapy. Structural study of mTORC1 is hampered by technical difficulties in sample preparation and structure determination. Yanhui Xu from Fudan University and collaborator groups (Jiawei Wang and Hong-wei Wang from Tsinghua University) reported the cryo-electron microscopy (cryo-EM) structure of human mTORC1 at 4.4 Å resolution—the highest-resolution mTORC1 structure so far. The structure reveals a number of key features, especially an unexpected topological arrangement of mTOR protein kinase. The study provides a structural basis for understanding the complex assembly and regulatory mechanism of mTORC1. The structure also serves as a framework for further characterization of mTORC1 and its regulatory proteins.

[Yang HR *et al. Protein Cell* 2016; **12**: 878–87]

NEUROSCIENCE

Neuropeptide coordination of mitochondrial unfolded response

Neurons are essential to systemically coordinate stress response and modulate longevity. However, the mechanism is largely unknown. Ying Liu's group from Peking University employed a tissue-specific CRISPR/Cas9 approach to disrupt mitochondrial function in the neurons of *Caenorhabditis elegans*, and observed the activation of an intestinal induction of mitochondrial unfolded protein response (mtUPR). The robust system allowed them to identify a neuronal sub-circuit that consists of three sensory neurons and the AIA interneuron for the propagation of mtUPR between tissues. They also found that neuropeptides, especially FLP-2, signals cell non-autonomous mtUPR, which coordinates mitochondrial function and metabolic adaptations across tissues (see Fig. 2). Therefore, the identification of FLP-2 may have therapeutic potential in the treatment of metabolic disorders associated with neurodegenerative diseases.

[Shao LW *et al. Cell Res* 2016; **26**: 1182–96]

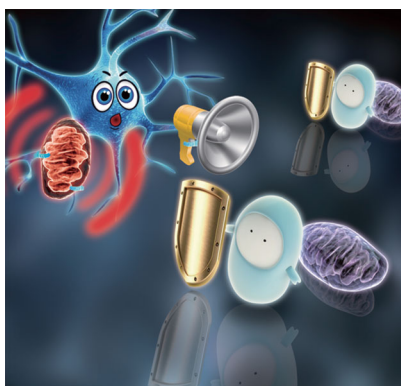


Figure 2. Schematic cartoon demonstrating that the neuropeptide signaling mediates cell non-autonomous mtUPR. Published in *Cell Res* 2016; **26**: 1182–96.

NEUROSCIENCE

Protective role of presenilin2 in an A β -induced Alzheimer's disease mice model

Accumulating evidence suggests that β -amyloid (A β)-induced neuroinflammation plays a prominent role in Alzheimer's disease (AD). Recently, Bing Du and colleagues at East China Normal University have discovered that loss of presenilin2 (PS2) facilitates neuroinflammation and injury by up-regulating P2X7 expression and the release of IL-1 β in an A β -induced mice model of AD. They also identified Sp1 as a transcription factor for PS2-mediated up-regulation of P2X7 expression. These findings indicate the potential protective role of PS2 in neuroinflammation and broadens the understanding of the role of A β deposition in AD formation.

[Qin JL *et al. Sci China Life Sci* 2017; **60**: 189–201]

GEOSCIENCES

Improved VDRAS analysis of a squall line

Plausible convective storm structures and short-term forecasts can be obtained by assimilating radar reflectivity and Doppler velocity into the Variational Doppler Radar Analysis System (VDRAS). Kun Zhao (Nanjing University) and co-workers modified the VDRAS to allow surface wind and temperature be assimilated into it to fill the radar data gap near the surface. A squall line is selected to investigate the performance of the improved VDRAS. The result shows that the additional surface data improve the analysis and newcast at low levels. Surface and low-level features of the squall line—including the surface warm inflow, cold pool, gust front and low-level wind—are much closer to the observations after assimilating the surface data in the VDRAS.

[Chen XC *et al. Adv Atmos Sci* 2016; **33**: 1106–19]

MATERIALS SCIENCE

Kicking toxic lead out: bismuth-based hybrid material as a potential alternative to lead halide perovskite for photovoltaics

Lead toxicity is one of the key challenges for the potential commercialization of high-performing lead halide perovskite solar cells. Recently, Lianzhou Wang at the University of Queensland and co-workers developed an effective strategy in addressing this challenge by using a bismuth-based hybrid material ($(\text{CH}_3\text{NH}_3)_3\text{Bi}_2\text{I}_9$) to replace lead halide perovskites for solar-cell application (see Fig. 3). Compared to the typical $\text{CH}_3\text{NH}_3\text{PbI}_3$ in the state-of-the-art perovskite solar cells, the perovskite-like $(\text{CH}_3\text{NH}_3)_3\text{Bi}_2\text{I}_9$ light-absorbing material shows advantages of superior stability and non-toxicity while still maintaining the solution processability. The successful demonstration of a $(\text{CH}_3\text{NH}_3)_3\text{Bi}_2\text{I}_9$ -based device provides a promising route towards environmentally friendly and low-cost photovoltaics.

[Lyu M *et al. Nano Res* 2016; **9**: 692–702]

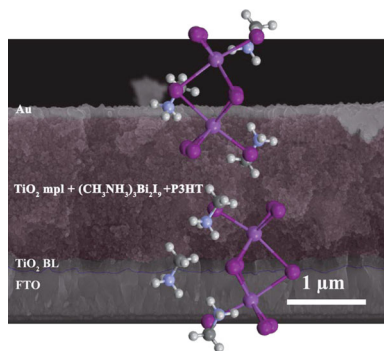


Figure 3. A typical scanning electron microscopy image of the $(\text{CH}_3\text{NH}_3)_3\text{Bi}_2\text{I}_9$ -based solar cells and the crystal structure of the light-absorbing material.

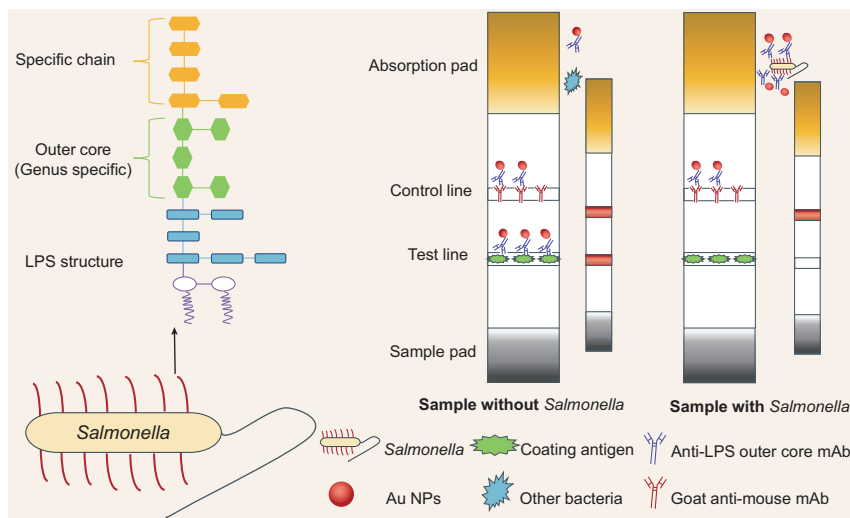


Figure 4. The colorimetric strip sensor for *Salmonella* based on gold nanoparticle-antibody conjugates. Red-colored lines appear in both the control line (C) and the test line (T) if there are no *Salmonella* infections in samples, while the red color appears only in the C section if the samples are polluted by *Salmonella*. Published in *Sci China Mater* 2016; **59**: 675–700.

MATERIALS SCIENCE

An efficient approach for reduced lateral size yet mono-layered carbon nitrides with highly improved photo-responsive properties

Quan-Hong Yang from the Graduate School at Shenzhen of Tsinghua University and co-workers developed a highly efficient ultrasonic technique to prepare reduced lateral size yet monolayer graphitic carbon nitride nanosheets. The resultant materials show highly improved photoresponse for cell imaging and photocatalysis under visible light. This study paves the way towards some special applications, for the development of mono-layered or ultrathin nanosheets with reduced lateral size, which fills the gap between high-aspect-ratio 2D materials and quantum-dot-like counterparts. [Liang Q *et al. Sci China Mater* 2017; **60**: 109–18]

MATERIALS SCIENCE

Naked-eye discrimination of *Salmonella* for food safety

Salmonellosis is regarded as a leading cause of enteric infectious disease related to foods. Hua Kuang and co-workers from Jiangnan University reported a costless and portable strip sensor (see Fig. 4), which directly detects 12 common *Salmonella* in milk with limit of detection low to single clonal formation unit (CFU). The high specificity of the proposed sensor was attributed to a species-specific monoclonal antibody against the lipopolysaccharide epitope from *Salmonella*. A red color in the test section of the strip apparent to the naked eye would disappear in 5 min once the tested milk is polluted by *Salmonella*.

[Wang W *et al. Sci China Mater* 2016; **59**: 675–700]

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