A label-free immunosensor based on an aptamer-modified graphene field-effect transistor (G-FET) demonstrated high sensitivity. Immunoglobulin E (IgE) aptamers with approximate height of 3 nm were successfully immobilized on a graphene surface, as confirmed by atomic force microscopy. The aptamer-modified G-FET showed selective electrical detection of IgE protein. From the dependence of the drain current variation on IgE concentration, the dissociation constant was estimated to be 47 nM, indicating good affinity and the potential for G-FETs to be used in biosensing.

**Journal of the American Chemical Society, 132, 18012-18013 (2010)**

Stimulated Raman scattering (SRS) microscopy allows label-free imaging of live cells with high contrast. However, an important issue of SRS microscopy has been its sensitivity because SRS signal is damped by laser noise. This paper demonstrates that the sensitivity limit can be achieved by using subharmonically synchronized two-color lasers. Experimentally, 38-MHz Yb-fiber laser pulses are successfully synchronized to 76-MHz Ti:sapphire laser pulses. By using these pulses, high-frequency lock-in detection of SRS signal is accomplished, and the effect of low-frequency laser noise is significantly suppressed. The noise level is found to be higher than the theoretical limit only by 1.6 dB. We also demonstrate high-contrast, 3D imaging of unlabeled living cells.

**Optics Express, 18, 13708-13719 (2010)**

A model was developed that simulates nationwide energy consumption of the residential sector by considering the diversity of household and building types. Since this model can simulate the energy consumption for each household category based on the schedule of the occupants' activities and a dynamic heat transfer model, various kinds of energy-saving policies can be evaluated with considerable accuracy. In this paper, energy consumption and CO2 emissions in the Japanese residential sector until 2025 were predicted. For example, as a business-as-usual case, CO2 emissions will be reduced by 7% from the 1990 level. Additional mitigation measures such as dissemination of photovoltaic panels were also evaluated.


Benzimidazole and its derivatives have attracted a great deal of attention because of their biological activities against several viruses such as HIV, herpes, and influenza. These compounds are however usually synthesized under strong acidic conditions and high temperature (ca. >200 °C). We developed an efficient and selective benzimidazole production process by photoradiolysis (λ>300 nm) of alcohol solutions containing α-arylamidines with TiO2 loading Pt nanoparticles (Pt/TiO2) at room temperature. This is promoted by one-pot catalytic transformations on the catalyst via a Pt-assisted photocatalytic oxidation of alcohols and a catalytic dehydrogenation of the intermediates on the surface of Pt nanoparticles.


Coherent diffraction microscopy using highly focused hard X-ray beams allows us to three-dimensionally observe objects with high spatial resolution, also providing us with unique structural information, i.e., electron density distributions, not obtained by X-ray tomography with lenses, atom probe microscopy, or electron tomography. We measured high-contrast coherent X-ray diffraction patterns of a shape-controlled Au/Ag nanoparticle and successfully reconstructed a projection and a three-dimensional image of the nanoparticle with a single pixel (or a voxel) size of 4.2 nm in each dimension. The small pits on the surface and a hollow interior were clearly visible. The Au-rich regions were identified based on the electron density distribution, which provided insight into the formation of Au/Ag nanobubbles.

**Nano Letters, 10, 1922-1926 (2010)**

The origin of low Young’s modulus in Ti-Nb-Ta-Zr alloys caused by softening in shear Moduli c’ and cν near Lower Limit of Body-centered Cubic Phase Stability

**Journal of the American Chemical Society, 133, 732-735 (2011)**

The development of new methods for selective syntheses of functionalized carboxylic acids with a controlled configuration is important due to the presence of these skeletons in biologically relevant compounds. We recently found a coupling method of 2,6-dinitro and internal aldehydes leading to five-membered carboxylic compounds by non-metallocene cationic hafnium-norbornene complexes as a first example of an oxidant-free cross dehydrogenative coupling reaction. Formally, the methyl group of 2,6-dinitro becomes a C1 source of the [2+2+1] cyclization reaction through the activation of two carbon-hydrogen bonds of the methyl group, and the double C=H activation on the same carbon atom is a new strategy for generating C1 sources for various coupling reactions.

**Catalytic cross dehydrogenative coupling reactions**

**<image>**

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