

## Science Last Fortnight

### Gender Equality, Sex Differences Competition and Mental Functions

There seems to be a general consensus that males are stereotypically more competitive than females. Of course, competition between women can be as fierce as that between men when reproductive success is concerned. But in the economic realm, women seem to compete less. This apparent lack of desire to compete has often been given as a reason for not finding women in top positions in professional fields. But now a paper in the recent issue of *PNAS* challenges the notion that women are not competitive. The paper presents data to show that if the arena for competition is related to benefits to offspring, then women are as competitive as men.

The same issue of *PNAS* has another paper that presents data on sex differences in the modulation of mental functions by circadian rhythm. The paper implies that night shift affects women more than men. The authors take pains to assure us that this is a matter of sex difference and not an issue of gender.

*PNAS*, 113(19), 5201–5205

### Kitchen Chronicles Rancidity of Ghee

Anhydrous, clarified fat derived from milk, commonly known as *ghee*, is an important component of traditional Indian diet. But oxidative rancidity, leading to change in colour, flavour, and nutritive value, limits its shelf-life. Synthetic antioxidants such as butylated hydroxyanisole and tertiary butyl hydroquinone are often used in anhydrous milk fat to improve its shelf life. But these chemicals are suspected of inducing tumour formation.

Researchers in Haryana Agricultural University, Hisar, and National Dairy Research Institute, Karnal, now suggest that lycopene, a red coloured pigment found in tomatoes, as a method to enhance the shelf-life of *ghee*. After adding lycopene to *ghee*, they carried out a series of tests to check factors like stability and rancidity. The tests

showed that lycopene suppresses formation of hydro-peroxides and lowers free fatty acid content significantly. Colour of *ghee* was stable during 12 month storage. Addition of lycopene in *ghee*, at levels as low as 30 ppm, significantly reduced the development of rancidity.

Since lycopene is a natural antioxidant, it is easily accepted as a food additive. Due to its radical scavenging activity it plays a role in lowering the risk of cardiovascular diseases and oxidative stress. So even people who have anxieties about their heart can now start making their food tastier with *ghee*.

*Food Chemistry*, 199, 541–546

### Biosensors: Increased Precision Detecting heart attacks, lipid

Most biosensors involve multistep colour changing reactions for detection of analytes. These tests are often expensive, time consuming and tedious. Moreover, the possibility of error at each step compromises the overall sensitivity of detection. Two significant advances in materials science reported in the last fortnight, signal emergence of new paradigms in biosensor technologies.

First is a sensor for early detection of heart attacks<sup>1</sup>. Scientists in the Central Scientific Instruments Organisation, Chandigarh, and the Institute for Genomic and Integrative Biology, New Delhi, report the construction of a sensor using graphene quantum dots (GQD) to detect heart attacks.

GQD emit blue radiations upon absorption of UV rays (360 nm). But when incubated with graphene, the fluorescence is quenched. At this point, any interference in GQD–graphene interaction can restore the fluorescence. Scientists leveraged on this property to make a sensor to detect heart attacks. They conjugated antibodies for troponin I, an extremely sensitive cardiac biomarker, with GQD. In the absence of troponin I, the GQD conjugate combine with graphene, causing loss of fluorescence. However,

when troponin I is present, it restores fluorescence, signalling heart attack.

Researchers tested the sensor using serum samples containing specific and non-specific biomarkers and validated the results using routine assays. The sensor was found to be highly specific for troponin I and could detect its presence even at levels less than 0.2 picograms/ml!

Only TiO<sub>2</sub> nanotube sensor boasts of such sensitivity, but TiO<sub>2</sub> nanotube sensor takes 120 minutes for detection while GQD biosensor can achieve the feat in just 10 minutes. Scientists are confident that given its robustness and sensitivity, the sensor will find use in routine monitoring of heart attack events.

Another significant advance in sensor technology in the last fortnight comes from a laboratory in South campus, Delhi University<sup>2</sup>. They reported creation of a sensor that can detect triacylglycerides in a single step, using a long period grating fibre – an optical cable with discontinuous imperfections. A light signal passing through such a fibre would produce altered transmission spectra.

E. K. Sharma and her team along with scientists in CSIR-CSIO, Chandigarh, first introduced imperfections in the optical cable and then immobilized lipase enzyme as a film on its surface. Lipase acts as a cladding on the fibre and changes the refractive index of the medium.

When immersed in a biological solution, the enzyme decomposes triacylglycerides to its components. The fatty acids liberated attach to the cladding and increase its thickness and refractive index. This, in turn, alters the transmitted light. The changes in the pattern of transmitted light were correlated to the concentration of triacylglycerides in the medium.

The researchers checked the possibility of interference from other analytes, using solutions containing physiological levels of urea, glucose, and ethanol. The sensor was not affected by the presence of other analytes; it was specific and could detect

triacylglyceride at very low concentrations. The results from the sensor can be seen within a minute.

Due to the ease of detection, high specificity and low response time, this sensor will be invaluable for routine monitoring of triacylglycerides in clinical settings.

<sup>1</sup>*Biosensors & Bioelectronics*, **79**, 495–499

<sup>2</sup>*Biosensors & Bioelectronics*, **79**, 693–700

### Graphene in Sensing Applications

*Contact with metal matters*

Electrons and holes have high mobility in graphene – a property that makes it a material of choice for a wide variety of applications. But contact resistance between graphene and metal is a limiting factor in applications such as radio-frequency devices and ultra-low power sensors. Several methods have been tried to reduce the contact resistivity. But to no avail. Last fortnight, researchers in Indian Institute of Science, Bengaluru, reported identification of the core of the problem: metal-graphene contact orientation.

Metal and graphene can come into contact in two ways. In the first, metal is placed on the top of graphene. In this architecture, monolayer flakes on a SiO<sub>2</sub>/Si substrate are used for lithographic processing. Then the contacts are made on top of these flakes, using electron beam. This fabrication method leads to uneven contact between graphene and metal due to the trapped photo-debris, point out the researchers.

They argue that placing metal on bottom of the graphene is far better. The fabrication process used in metal under graphene avoids impurities at the metal-graphene interface. This makes metal-graphene interface cleaner and hence resistance becomes lesser. Though it is a minor difference in the fabrication process, the difference in performance is significant.

Researchers also suggest reducing the metal-semiconductor barrier height as another parameter to be considered to reduce contact resistivity.

The reduction in the resistivity of graphene-metal is expected to give a fillip to research and development of applications including, batteries, capacitors and sensors.

*Nanotechnology*, **27**, 205705

### From Green to Clean

*Putting waste to use*

In a bid to put biowastes to use, scientists from Centre for Environmental Science and Technology, Central University of Punjab tested the efficiency of western Himalayan spruce cones in removing chromium from water.

Hexavalent chromium ion is a common industrial pollutant which is toxic to humans. It is traditionally removed from the industrial effluents through various techniques: ion exchange, chemical precipitation and adsorption.

The western Himalayan spruce produces cones rich in lignocellulose, a natural polymer with heavy metal adsorption properties. The researchers compared its chromium adsorption ability against an industrially used adsorbing agent, activated charcoal.

Batch adsorption studies reveal that spruce bio-waste is 73% as efficient as activated charcoal. With an efficiency of 228 mg/g, it stands at the higher end of the efficiency spectrum in comparison with other biowastes in terms of metal adsorption. Since the spruce cones serve no significant purpose and are usually burnt by local people, it can be developed as a low-cost adsorbent for removing toxic chromium from industrial effluents and other water bodies.

*Desalination and Water Treatment*, **57**, 11081–11095

### Old Computer, New Uses

*E-waste management*

Each year, about 30–50 million tonnes of electronic gadgets are rendered obsolete, generating huge amounts of solid waste. In Africa and the Indian subcontinent where there is a continuous inflow of second hand devices and the standard of recycling is poor, the picture is even more dismal. While existing measures attempt retrieval of metals from E-wastes, V. Sahajwalla and her collaborators from IIT Delhi, focused on the plastic waste.

Plastics form a quarter of the generated E-waste. Presently, they are used as feedstock for smelting processes. But a part of non-metallic print circuit board waste can also be used as filler

for the synthesis of reinforced polypropylene.

The researchers isolated the plastic component of scrap computers from crushed motherboards and mixed it with different proportions of polypropylene to form polypropylene-PCB waste composites. They studied the composites by spectrometry, calorimetry and microscopy to determine the changes in structure and properties.

Results reveal that adding PCB plastic increases the crystallinity of polypropylene composites. PCB induces heterogeneous nucleation creating smaller, irregular areas in polypropylene matrix and thus increases the flexibility of the product.

These composites proved to be thermally stable, making PCB plastic an attractive substitute for costly fillers. Researchers are confident that such value-added recycling measures will help tackle the growing problem of E-waste management.

*Journal of Applied Polymer Science*, **133**(18), 43389

### Academic Achievement

*Genome-wide association studies*

Educational attainments depend on environment and upbringing. Right? Well, not completely. About 20 percent is dependent on genetics, says a paper in *Nature*. So it is not a nature versus nurture debate any more. It is nature and nurture.

Scientists have increased the cohort from the earlier study reported in 2014 to about 3 lakh people now and using genome-wide association studies have located 74 loci which call the shots when it comes to how many years of school one goes through.

The single nucleotide polymorphisms and the genes identified are preferentially expressed in the brain. Some of them are associated with neural development. Scientists say that many of them may also be related to cognitive abilities and psychiatric disorders.

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