PHLburg Technologies, Inc.

1275 Drummers Lane
Suite 101
Wayne, PA 19087

Telephone: 610-688-6800
Fax: 610-975-5800
Website: phlburg.com

November, 2011

Dear ,

IN THIS ISSUE:

MESSAGE FROM NEIL B. GODICK

The anti-smoking drive has finally reached Russia. The Ministry of Health and Social Development has proposed a fairly tough bill that (1) bans smoking in public places (2) raises tobacco prices and (3) changes the way smokers will purchase cigarettes. Once enacted the legislations will prohibit/removes cigarettes from shop windows and counters. Though cigarettes will still be available, smokers will have to select them from a special catalogue. They will not be on display.

Cigarettes will disappear from shop counters as early as 2013. Smoking on long-distance trains and in smoking lounges at airports and railway stations will be banned starting in 2014. Beginning in 2015, smoking will be banned in cafes, restaurants and nightclubs.

Movies and TV shows featuring characters smoking will be outlawed. Office smoking rooms are to be "moved" outside. It is anticipated that smokers may find themselves with only one place they can smoke: their own apartments. Those who are unwilling to pollute their homes and are accustomed to smoking on stair landings will have to obtain permission from their neighbors.

Russia is near the top on the list of world tobacco consumption: 72% of men, 35% of women, and 50% of teenagers smoke. Today cigarettes are totally and easily available. Cigarettes can be bought cheaply on almost every corner: a pack of Marlboros costs $1.80 in Russia significantly less than in Europe or the United States. The cheapest cigarettes in Russia cost about 17 rubles a pack just over 50 cents.

In recent years, the government has become acutely aware of national health problems and moved to discourage smoking, mostly through propaganda. Cigarette packs now feature warnings, and on television, showbiz stars are urging young people to quit smoking.

All of this said - it appears that the only anti-smoking measure that might be effective is increasing cigarette prices.

We do not intend for the following reports to solve any need our readers may have. We do intend to keep everyone current on technology developments in Russia. If you would like any additional information on any of the developments reported – send us a note.

Nerve cell under a laser microscope

Lomonosov Moscow State University and RAS All-Russia Research Institute of Optico-Physical Measurements (Moscow) using laser interference microscopy (LIM), developed approaches to produce a detailed assessment for living nerve cell status. They can measure various axon parts – the biggest neuron protrusion.

This gives researchers a tool to study living tissues and cells. Most modern microscopy methods require fixing and staining the biological object. This often distorts the object's native structure. The new method attempts to achieve better insights into what happens within a living cell.

The basic principle used to examine objects by LIM is measuring their optical properties, environment, and the object's height at the measurement point. The object's width measurement is the same as for ordinary optical microscopes. The object's height measurements are much more accurate because LIM enables achieving 2.5 nm vertical measurement accuracy.

The nerve cell has many protrusions. In large vertebrates, the axon, the longest protrusion, can be a meter or more long. On the outside, it is sheathed in myelin fiber formed by multiple membrane outgrowths (Schwann cells) wrapping around axons. But this coating is not homogeneous and is repeatedly broken in places to form Ranvier constrictions (nodes). These play a very important role in the nerve impulse transmission process.

Using LIM, the scientists were able to measure the nerve fiber diameter and axon diameter in the Ranvier constriction. They could also measure the lengths of the Ranvier constriction and sections between them. Where the myelin contribution to the fiber thickness is at its maximum, the measurement accuracy is about 40 nm. In the Ranvier constriction area where the membrane share is minimal, the accuracy is about 300 nm. In other nerve fiber sections, the method's accuracy will change depending on the myelin share. Therefore the researchers think that the method makes it possible to fairly accurately assess nerve fiber geometry and functional status.
#2011-09-183

Laser accelerator

A laser accelerator needs a laser and a gas cloud. Passing through the gas, a powerful laser pulse pushes electrons out of its path. It is possible to achieve a mode when, behind the pulse, a region is formed that practically has no negatively charged particles (*a hole*). It is in this region that the most efficient electron acceleration can be achieved. *The hole* moves after the laser pulse. In the opposite

direction it is passed over by electrons pushed out by the laser. Electrons that enter the hole will be accelerated.

Researchers call this new structure a *bubble*. It does look like a bubble – without electrons inside and with an electron film outside. Only electrons that get inside the bubble can be accelerated. It is this electron embedding method that is considered **FIAN's (RAS Lebedev Physics Institute)** great achievement. FIAN's researchers created a technique to reach a radically new electron energy level – 1.5 GeV.

The scientists' idea was to replace helium as the active plasma material. Helium is typically used because it is very easily ionized by laser. However the laser pulse forefront has low intensity and blows off all electrons from helium atoms. Most electrons move far away from the bubble. Therefore it was suggested to use a heavier gas, e.g. nitrogen or oxygen whose total ionization is higher.

Both laser-induced particle acceleration and slowdown are relatively new research areas. Some practical applications could be found for them. In addition, extreme states can be reached that cannot be reached in any other way. Scientists hope that, when accelerated by laser, protons could reach huge magnetic field values within narrow spatial regions – up to 10^6 Tesla. Fields with that order of magnitude are found in some remarkable objects in the Universe - neutron stars with their huge density – up to 10^{18} kg/m^3.
#2011-09-184

Using plants' physiological rhythms

Stavropol State Agrarian University (Stavropol) developed a technology and equipment providing that delivers substantially higher power efficiency, while simultaneously improving seedlings' quality when grown in a greenhouse. Skills in plant growth and physiology and engineering were involved in solving this problem.

All living creatures – from bacteria to humans – have an "internal biological clock". It regulates both seasonal and daily rhythms – we usually sleep at night and are awake in the daytime. Such fluctuations in biological processes intensity related to day-night-day changes are known as circadian rhythms. Plants have them too. Photosynthesis - a key process for most biomass formation on this planet – greatly changes its intensity during the day.

The researchers asked themselves if this knowledge could be used to more efficiently grow vegetables in a greenhouse (e. g., by adjusting the illumination intensity to plants' physiological rhythm). They found that the answer is "yes". They developed a variable illumination technology, manufactured appropriate equipment and an illumination control system based on an electron start-control device. The system was tested and adjusted in an experimental greenhouse. All illumination modes were selected experimentally after many

experiments. The experiments involved controlling plant growth parameters (internode length, dry and wet biomass weight, and photosynthesis pigments content). In addition various illumination sources and their spectra were analyzed. Specific illumination modes were selected for various agricultural crops.

The new technology's essence is as follows. During a lower photosynthesis intensity period when plants' physiological rhythm adjusts itself to the natural daily illumination rhythm, they are irradiated with a low intensity light for the period required to develop the highest basic photosynthesizing pigments' concentration. Then the mode is changed to the high illumination mode for a period required to develop the maximum photosynthesis intensity.

By using variable irradiation, the researchers reduced the vegetable seedlings' growth period by 20–25% while simultaneously enhancing their quality. This, in its turn, enabled them to gather earlier and higher (15–20% on average) crops than by using conventional technologies. At the same time the variable illumination mode reduces electric power consumption by 38–40% compared to the standard mode. This offers a major advantage as, considering continuous growth in electric power costs, it reduces the final product cost.

Further technologies are being developed in the experimental greenhouse. Soon these new methods will find wide application in greenhouse farms. More than a dozen papers have been published and five patents have been obtained based on this work.
#2011-09-185

Studies in controlled movement of graphene structural defects

Today graphene, whose structure is one-atom-thick bonded carbon sheets, is a wonder material. At the same time graphene is the strongest and most elastic known material. However these incomparable properties belong to ideal graphene with minimal impurities and homogeneous crystalline structure. It is obvious that any structural defects will affect its elastic and electronic properties.

RAS Siberian Branch Kirensky Institute of Physics (Krasnoyarsk) has completed a theoretical study on graphene's structural defect effect on its elastic properties. The defect considered was the vacancy. Vacancy is understood as disturbed periodicity in atoms' arrangement in the graphene structure.

To study elastic properties, the researchers determined the Young's modulus. This coefficient characterizes a material's ability to resist compression or stretching. Young's modulus for aluminum is about 70 GPa, for steel 210 GPa, and for ideal graphene it is about 1,000 GPa. The researchers determined that the more graphene structure defects the lower the Young's modulus. The dependence was strictly inversely proportional.

In addition to this parameter, the researchers assessed vacancies' movement rates in graphene depending on the applied strain direction. This is important for controlled defects movement within graphene. Vacancies' movement rates changed considerably (both increasing and decreasing) depending on the sample's compression or stretching.
#2011-09-186

Predicting nanoparticle dimensions

Nanoparticles' huge free surface area and unique magnetic and optical properties present many possibilities for application. One simple and effective method to obtain nanoparticles is mechanically grinding coarser powder particles. Nanoparticles with fixed composition and dimensions are often required to solve specific technology problems.

RAS Ural Branch Institute of Solid State Chemistry (Yekaterinburg) developed a model that can reliably predict dimensions for nanoparticles produced by grinding. The model's results agreed with experimental data for tungsten carbide production. It was found that particle dimensions decrease with longer grinding times and increase with higher source particle dimensions and sample weight.

Powders are mechanically ground in a planetary ball mill. The researchers made a preliminary ball movement analysis. It showed direct dependence between the energy expended and grinding time at a fixed mill rotation rate. Energy is expended breaking chemical bonds and significant increase in particles' free surface.

The final model describes particle dimensions as a function of grinding time, sample weight and source particles' dimensions. Shear and compression moduli, crystal lattice parameters, etc., are used for the physical characteristics in the model. According to the model, higher sample weight and source particles' dimensions, or shorter grinding time results in coarser particles.

The experimental data on grinding coarse (10 µm) tungsten carbide powder down to nanosize (10 nm) agreed well with the model. The model makes it possible to change from empirical grinding condition selection to a theoretical grinding parameter determination based on the source material's physical characteristics.
#2011-09-187

Reinforcing rubber with clay

Rubber strength increases by including montmorillonite (mineral in the laminated silicate subclass) in its composition. Physical causes for these rubber property changes were studied by **Kazan State Technology University (Kazan)** scientists.

Rubber is among the most frequently used composite materials. The

composite's properties depend both on the raw rubber type and on various fillers within its composition. That is why, to obtain quality rubber, searches for optimum polymer rubber and filler combinations must be made.

Montmorillonite is a promising rubber filler. If a small amount of this mineral is added to rubber, its strength properties will be substantially enhanced. Industrial rubber is a mixture of different components (fillers, pigments, various additives). To understand how montmorillonite-based laminated silicates affect its properties, it is necessary to study this mineral's interaction with the pure polymer used in the rubber.

Researchers studied laminated silicates' effect on siloxane rubber's physico-mechanical properties. Siloxane rubber is the source polymer used to make heat-resistant and biologically safe general rubber goods. Ground laminated silicate was added to siloxane rubber to give a final 5% silicate concentration. Several siloxane rubber samples were prepared, each containing a silicate from a different source. They included laminated silicates from Sarinskoe deposits (Russia) and several polymer additives based on US-produced silicates. It was determined that the siloxane rubber samples containing laminated silicates have higher strength values. According to the scientists, this strengthening can be explained by the polymer penetration into the mineral's interlaminar space. These results can be applied to produce new composite materials where laminated silicates are used as fillers.
#2011-09-188

Magnetic bioceramics for cancer treatment

RAS Ioffe Physical-Technical Institute (Saint-Petersburg) developed a new magnetic ceramic class for biomedical applications. The synthesized composite has good biocompatibility. Its magnetic parameters are greatly superior to medical bio-glass-ceramics.

Single-domain ferrites were used to make the material. Their particle dimensions are extremely small. They contain just one fragment with coordinated magnetic moment direction and behave like permanent magnets. There are many applications for magnetic particles, e.g. in health care they are used to increase image contrast in magnetic resonance tomography.

Magnetic particles are also very promising for targeted tumor treatment. When exposed to an alternating magnetic field, ferrites release heat (tumor cells die at 42–45°C). The next step is to embed ferrite particles into the composition's biocompatible material, deliver it to the tumor area and generate an alternating magnetic field.

Magnetic particles are heated due to heat losses from the material's reverse magnetization hysteresis or chaotic particle magnetic moment

re-orientation. The first mechanism's contribution grows as the ferrite dimensions increase and falls as they decrease. The second mechanism produces a strictly reverse dependence. Therefore determining the ferrites' optimum dimensions and composition is important.

A magnetic biocomposite based on hydroxy apatite (HA) was developed. This ceramic material's excellent biocompatibility is related to its chemical and structural affinity to the bone mineral component. Selected for The magnetic particle source was $BaO \bullet 6Fe_2O_3$. After being dried and ground in a ball mill HA and ferrite powders (ratios: 20:1, 10:1 and 5:1) were pressed into samples and sintered in a moist ambience at 1200°C.

The resultant bioceramic samples retain HA's high bioactive properties. An increase in magnetic filler concentration improves the final ceramics' quality – the thermal effect from reversal magnetization used for destroying cancerous growths is intensified. These new bioceramics have greatly improved magnetic characteristics compared to other similar developments.
#2011-09-189

Stem cells to restore blood vessels

Kirov Military Medical Academy (Saint-Petersburg) developed a technology for targeted drug-cell delivery to save body tissues from inevitable death.

During some diseases (e. g., diabetes mellitus or atherosclerosis), large arteries cease coping with their job (delivering oxygen and other necessary substances to various organs) properly. This gives rise to ischemia – a delay in blood supply to tissues. The more distant these tissues are from the heart, the stronger ischemia's destructive consequences. Therefore people with quite different diseases that affect proper heart and vessel functioning often face the same problems – lower limb ischemia. The body needs help restoring blood vessels. There are grounds to believe that stem cells could solve this problem by creating necessary conditions for vessel regeneration. The key points are to select the right source for these cells and deliver them precisely to their destination.

As a proof of principle, the Kirov Academy scientists developed an experimental model for chronic ischemia in animals' femoral artery. The animals were injected with mononuclear fractions of bone marrow cells from genetically close individuals in the same population. It was found that this procedure was quite safe and effective. The researchers observed a significant capillary growth in the damaged limb and a new auxiliary collateral blood flow.

The researchers solved another important problem during this work. Since the vessel regeneration rate is key, it was important to answer the question *what is the most efficient method for drug-cell delivery*?

A combined method was developed. The optimum technique is to inject stem cells both intramuscularly and intra-arterially. As a result of intramuscular injection, stem cells form long-term slowly developing foci for new vessels' generation, while from intra-arterial injection this process is fast. These two stem cell delivery methods are mutually supplementary. The stem cell delivery method has been patented (RU2369399).
#2011-09-190