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MESSAGE FROM NEIL B. GODICK

Trends we have come upon in recent readings:

Consumers - In 1990, Russian households spent 41 % of their income on food; last year that share was 35 %. Relative to developed countries, however, Russian households still spend a sizable chunk of their income on food. In 1990, 46 % of income went to nonfood goods purchases. Last year that share was 38 %. The share of services doubled from 13 % in 1990 to 27 % in 2009. Many home appliances have become standard in the last two decades. In 2009, there were over 100 refrigerators, 100 washing machines and over 200 mobile phones per 100 households. There were also about 50 cars and 50 computers per 100 households last year.

Public Health - The transition to a market economy and democracy in the 1990s in Eastern Europe and post-Soviet Eurasia caused dramatic increases in mortality rates and shortened life expectancies. In particular, the steep upsurge in mortality and decline in life expectancy in Russia were the greatest ever recorded anywhere in peacetime and in the absence of catastrophes such as wars, plague, or famine. Between 1987 and 1994, Russia's mortality rate increased by 60% from 1.0 to 1.6 %. This is a level that has not been seen since the first half of the twentieth century. Meanwhile, in the same period, life expectancy declined from 70 to 64 years.

The Russian mortality crisis was caused by a shock-therapy-type marketization of the economy. This led to a dramatic rise in stress factors. These included income inequality, unemployment, labor turnover, migration, crime, and divorce. These social factors were mostly responsible for the unprecedented 60 percent increase in Russia's mortality rate. Alcohol consumption, although strongly correlated with the mortality rate, was most likely not the core cause but a symptom of the same stress factors.

Business - The best places to do business in Russia include the Ulyanovsk, Kaluga and Yaroslavl regions. This reputation was achieved by a carefully prepared infrastructure, business parks, and

governors who are prepared to get personally involved in attracting business.

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.

Unique Detector for Explosives Created

Russian physicists have built a unique device – a photonuclear detector for hidden explosive substances. The device detects explosives in luggage and various closed containers. The device can be used as a portable detector for demining activities.

A closed container exposed to high-energy gamma-radiation, nitrogen and carbon nuclei become covered with boron and nitrogen isotopes (^{12}B and ^{12}N). These elements have very short lifetimes. They can be detected separately from other radionuclides. Signals from these elements indicate possible explosive substances' presence.

A technique, developed by the Russian physicists creates a chemical compounds' portrait. The "portrait" is created when the compounds are exposed to gamma-radiation. Comparing these "portraits" with the detector signal distinguishes explosives from ordinary safe substances containing nitrogen and carbon. The detector can even determine what explosive is hidden in a container. Gamma-quanta have enormous penetrating power – this enables detecting explosives covered with metals, water and soil. Narrowing the radiation beam results in finding the explosive's exact location and shape.

The theory behind the photonuclear technique first appeared in 1985. Russian researchers decided to put theory into practice. Funds for the project came after the 9/11 attack. The Russian scientists have built a detector prototype. All its components, including portable electron accelerator (a split microtron), secondary radiation detector and signal processing module are fully tested.

The device requires only 2 seconds to check one item. This short processing time makes the detector useful for high volume applications.

The detector has another application – it can be incorporated into a robotic mobile complex for demining activities. Unexploded ordnance, left after military campaigns, is a serious problem for more than 60 countries. Russian scientists demonstrated a computer model showing the device's safety and reliability and that the development meets all existing UN standards for unexploded ordnance (UXO)

clearance. An automatic detector can replace widely used manual demining technology thereby reducing unnecessary risks and making demining much faster.
#2010-11-126

Giamatrix – New Artificial Skin

"Giamatrix" is an innovative bioplastic material that covers injuries and severe burns, helps heal them, and dissolves itself. The new material, based upon polymerized hyaluronic acid, allows patients to avoid painful dressings.
"Giamatrix" is made by photopolymerizing natural hyaluronic acid. The new artificial skin has excellent bio-engineering properties – elasticity, adhesion and mechanical strength. Photopolymerization forms lateral links between linear hyaluronic acid subunits. These links are formed without chemical agents. The biomaterial covers an injury, sticks to it, and helps it heal faster. This is achieved by creating a favorable microenvironment for migration and mitotic cell activity. The developers claim no other artificial skin can do that.

The researchers plan to start commercially producing their innovation. Seventy-five cm^2 of artificial skin HYAFF, made from chemically modified hyaluronic acid, cost $135, while 150 cm^2 of Giamatrix is expected to cost $40.

Currently, the biomaterial does not have full Russian medical approvals for use.

"Giamatrix-Light" has also been developed. This is a peptide complex using the same hyaluronic acid. It can be purchased in some pharmacies in St. Petersburg. This artificial skin version was designed especially for the beauty industry – cosmetic surgery, dermabrasion and peeling. Peptides provide normal cell function, restore their activity, regulate cell immune reactions and stabilize cell metabolism. Being small chemical compounds, peptides reach deep skin layers, reduce inflammation and recover the skin's own protective mechanisms. Peptides launch self-regulation processes which slowly weaken with age and under aggressive environment.

"Giamatrix" can be stored without special conditions. The biomaterial can be used in combustiology (treating burns with various severity levels), surgery, patients with gravitational ulcers, neurodermatitis and psoriasis, otosurgery, and cosmetology.
#2010-11-127

Solar Patrol to Fight Corrosion

Russian space physicists from Vavilov State Institute of Optics developed an unusual technology for fighting corrosion found in oil and gas pipelines.
Nearly half of all accidents on Russian gas pipelines are caused by

abnormally high external stress corrosion. The average corrosion speed is about 0.25 mm per year, but sometimes is reaches 1.16 mm per year. Corrosion reduces pipeline lifetime to 5-10 years from the normal 25-30 years.

Russian physicists obtained data, showing that major pipelines and large electric networks were affected by *space weather. Space weather* is labeled as – powerful geomagnetic storms and solar bursts. These phenomena are known to cause geomagnetically induced currents in pipelines located in latitudes more than 50 degrees north. Researchers noticed that when the Sun was active, major pipelines' cathodic protection stations often switched off or collapsed. Pipes, left without electrochemical protection, suffer from accelerated corrosion.

When a magnetic storm takes place, Earth's ionosphere is invaded by billions of energetic particles – electrons and protons. Coming from the magnetosphere and radiation belts, they create additional ionization then upper atmosphere. Excessive ionization promotes ionosphere current systems to form. These systems generate electric fields. These electric fields together with geomagnetic variations cause geomagnetically induced currents on Earth's surface and in various conducting systems over and inside the ground during geomagnetic storms.

To prevent a sharp rise in corrosion rate in major pipelines, Russian scientists are creating a space monitoring service. This service, not yet operational, will inform pipeline managers about possible geomagnetically induced currents' effect on pipelines and define "tranquility gaps". During these periods cathodic protection stations are switched off. The predictions are based on heliophysical activity measurements using an electro-optical system "Space Solar Patrol". The electro-optical system was designed in Vavilov State Institute of Optics. Radiometers and ionizing radiation spectrometers make up the system.
#2010-11-128

A new biosensor for lactic acid

Moscow University scientists have developed a new lactate biosensor.
Biosensors are analytical devices using biological materials for detecting certain molecules. An electrical signal provides information on their presence and amount. The basic biosensor analysis principle follows. A biomaterial (enzymes, cells, etc.) is fixed on physical sensors. As they interact with analytes, the material generates a concentration-dependent signal. The signal is detected by a transducer.

Among the most frequently analyzed compounds is lactic acid and its salt – lactate. These two compounds are a universal metabolic product

for virtually all living organisms. They are also a natural or artificial component in many food products.

The most promising lactate biosensor is an enzyme electrode based on lactate oxidase. However, as this enzyme is unstable and highly active, existing lactate biosensors have low sensitivity and low stability.

Scientists have produced highly active and stable enzyme-containing membranes. They developed a lactate biosensor whose analytical parameters are at least tenfold higher than those currently available. To produce the biosensor, they developed a current-free method for applying an electrocatalyst to the sensor's working electrode surface.

The researchers tested their lactate biosensor samples on people. They measured lactic acid levels in sportsmen (as an endurance indicator). However, the currently used method for this testing involves periodic blood sampling. This was unacceptable. So the authors developed a method to determine lactate in sweat. Tests confirmed the biosensor's high sensitivity and reliability.

To develop the enzyme-containing membrane, a new method was created. It involved enzyme immobilization from water-organic media with high organic solvent content. Prussian blue is the most efficient electrocatalyst for hydrogen peroxide reduction. It was used as a transducer. Three-electrode planar sensor structures manufactured by screen printing were developed. A new technique was used for current-free electrocatalyst (Prussian blue) deposition onto the electrode surface. The technique involves boundary precipitation from a ferrocyanide and 3-valent-ferrite mixture in the reducer's presence.

The new planar lactate sensor has the following analytical characteristics. Sensitivity: at least 50 mA M $cm^{-2;}$ detection limit: not more than $1•10^{-7}$ M. Compared to other systems, this is an order of magnitude higher and lower respectively. The biosensor calibration scale is linear within three orders of magnitude (from $1•10^{-7}$ M to $1•10^{-4}$ M). This makes the biosensor useful for analyzing real objects. The biosensor is stable for at least 500 analyses before it requires re-calibration.
#2010-11-129

No biopsy now required for liver disease diagnosis

Hepatic fibrosis is a disease requiring biopsy for its diagnosis. Children's Health Research Center, RAMS specialists have developed a method that eliminates the need for this painful procedure. Using this new development, hepatic fibrosis stage determination is based on biochemical indicators.
Liver cells (hepatocytes) are grouped in lobules surrounded by

connective tissue. During fibrosis, the tissue spreads out while the hepatocyte number goes down. Fibrosis grows progressively worse and passes into cirrhosis. Cirrhosis produces irreversible structural changes in the liver. To determine the hepatic fibrosis stage, a biopsy is used. Biopsy enables assessing the connective tissue-hepatocyte ratio. This procedure is painful and not totally safe. For patient comfort physicians use biopsy as seldom as possible. However, without biopsy, doctors cannot correctly assess the fibrosis propagation degree or treatment efficacy. So they look for noninvasive methods for hepatic fibrosis diagnosis.

Liver connective tissue spreading is accompanied by biochemical changes whose nature is known to specialists. There is a considerable increase in the TGF-β1 (transforming growth factor-β1) protein, collagen type IV, and hyaluronic acid content. Metalloproteinase 2 and 9 (MMP-2 and MMP-9) enzyme activity is reduced. However, medical researchers did not know if these substances' blood level could indicate hepatic fibrosis degree.

To find an answer to this question, Children's Health Research Center, RAMS specialists examined 95 patients aged from 1 to 17 with various chronic liver diseases. The control group included 15 healthy children. All the examinees were tested for hyaluronic acid, collagen IV, TGF-β1, MMP-2 and MMP-9 content in their blood serum. They were also tested for lectin content. In addition, liver biopsy was performed on all the sick children.

Having compared the biopsy results and biochemical analysis indicators, the researchers came to the following conclusions. Changes in MMP-2 and TGF-β1 serum concentrations enable diagnosing minimal changes in the liver. Hyaluronic acid and collagen type IV levels indicate expressed hepatic fibrosis and cirrhosis. These biomarkers can be used to determine fibrosis stages and to observe disease progress dynamics in children with chronic liver pathologies.
#2010-11-130

Method to obtain a glass-crystal dielectric with dielectric permittivity regulated within a wide range

A Russian business developed a production method for a new glass-crystal ferroelectric with dielectric permittivity regulated within a wide range.
This new method enables producing high-strength pyrocerams in any complicated configuration. The new method uses both glass-making and ceramic industry molding techniques (pressing, casting, etc.).

Existing production methods to obtain ceramic ferroelectrics based on barium titanate have significant disadvantages. These are manufacturing problems with large-size products and products with gradient dielectric permittivity. These problems would be solved by

using directed $BaTiO_3$ crystallization in glasses with appropriate composition. However, all known glass compositions for producing pyrocerams with high crystalline $BaTiO_3$ content tend to exhibit spontaneous (uncontrollable) crystallization and have a high (up to 1,700 °C) melting temperature.

The company developed raw mixes that form stable glasses in the BaO-B_2O_3-$Al2O_3$-TiO_2 system with a relatively low glass melting temperature. The mixes can consecutively form various crystal phases during different secondary heat treatment stages ($Ba_4Ti_{10}Al_2O_{27}$, $BaO•2TiO_2$, BaTiO3). Nanosized $BaTiO_3$ crystals are formed at the final processing stage. This produces pyrocerams with phase composition (and consequently dielectric properties) that can be adjusted within a wide range.

The production technology for similar glass-crystal materials has been mastered at the company's pilot plant.

The production method makes it possible to synthesize pyrocerams with strictly determined dielectric permittivity values. Pyrocerams with gradient phase composition (i.e. with a predetermined dielectric property gradient) can be produced in gradient furnaces.

The proposal's main advantages

- Relatively low basic glass melting temperature (1350 °C).
- Dielectric permittivity values of pyrocerams based on those glasses can vary between 18 and 760.
- Relatively low dielectric loss tangent value (0.06-0.07).
- High mechanical strength for the pyrocerams produced (compression strength: 200-380 MPa).
- Ability to make complicated configuration products.
- Ability to make products with preset dielectric permittivity gradient values.

#2010-11-131