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MESSAGE FROM NEIL B. GODICK

On November 30, Russian President Dmitry Medvedev delivered his third state of the nation address to both houses of parliament. His speech to the Russian parliament was broadcast on state television and lasted for about one hour and 15 minutes.

Some of the more interesting parts of President Medvedev's address included:

- Agreement on missile defense system will either be reached within the next decade or Russia will need to deploy new strike forces

- Bribe takers should be fined 100 times the amount of the bribe and intermediaries in bribe taking should also be penalized under Russia's Criminal Code
-Russian authorities at all levels must get rid of property unrelated to their work

- Russia will discuss the scrapping of visas and Russia's accession to the WTO at the Russia-EU summit in Brussels next week

- At least 50 percent of saved budget funds as well as additional income to the federal budget should be spent on the economy's modernization

- The rate of payroll based insurance premiums accessed Russia's small businesses in 2011-2012 will be cut from 34 percent to 26 percent.

- The government should prepare proposals on penalizing officials for not performing their duties in a timely manner

- Russia should reduce annual inflation to 4-5 percent in the next three years

- Russian families should be given a plot of land to build a house on, as well as tax breaks, after the birth of a third child

- Russia will spend 30 billion rubles (about $1 billion) on the joint research work of the country's leading universities and major companies

- Russia will increase the share of national products on the pharmaceutical market from 20 to 50 percent in the near future

- Russia will allocate 2 billion rubles for teacher training

- Heads of Russian regions should make annual reports on the environmental situation

- The Russian government and regional authorities should focus on the development of a military and patriotic movement in the country

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.

Interface for handling quantum information

A key quantum photonics problem is how to construct an interface between light and atoms. A joint research group from P.N. Lebedev Physical Institute, RAS and Harvard University is studying the interaction between quantum objects and single photons.

Among other important tasks in quantum photonics is building an interface between atoms and photons. A Russia-United States research physicists team is studying how single photons interact with quantum objects. The team has built a prototype device for transferring information from an atom to a photon. The device is an integrated chip in an artificial atom with a fibre port. The device's simplest future application is a memory cell. More complicated applications include a single-photon transistor, working on the individual quanta level, for building complex logic systems.

The team's principal focus is building an interface between light and atoms or artificial atoms. Building this interface means:

- learning to create some given kind of a state in a system (such state is called superposition),
- reading it without damaging it, and
- transferring the information to another object.

This predetermined state is superposition for two or more atomic energy states. These states can be measured with certain probability. This is known as quantum information. It is transferred to the light. Its carrier is a single photon. This information is transferred to light, which is reliably detected – information on a photon can be "read". In other words, this is a channel for quantum information transfer from a memory cell to another cell or to an output device.

The group has already developed an interface with artificial atoms. The artificial atoms are quantum dots and color centers in diamonds. Structures in the diamond crystalline matrix where the carbon atom is replaced by a nitrogen atom. They are called artificial atoms because their energy level structure is similar an atom. A superposition state can be created within them. Artificial atoms, especially color centers in diamond, have a long-term memory. Their nuclear spin life is about a second. This is certainly not a hard disk but it is quite sufficient for RAM (as operations can be performed within microseconds).

The new device is a silicon chip with objects placed on it. The artificial atom role is played by a 50 x 50 nm diamond crystal with a color center. The crystal is placed on a 100 nm silver wire combined with a light-conducting dielectric waveguide. The work is conducted at room temperature using a specially built confocal microscope for observation. One microscope channel shows a sample area image for choosing the desired object and the right dot on it. Then laser radiation is focused on that dot and the color center releases single photons that can be experimentally detected. The other channel scans the surrounding area and collects information from any glowing dot. It might be a wire or waveguide end. The excitation beam can be moved along the sample and collect radiation data from different centers.

Researchers successfully created an interface between a photon and a quantum object (an atom). They have a technique of creating stable working chips, they can register individual photons and calculate correlation functions. However, scientists can register only 60% of the photons.

There are numerous practical applications for this technology – from memory cells to transistors and complex elements with single-photon logic. New technologies for communication and quantum computers are closer with this technology.

Nanoparticles against the flu

Titanium dioxide nanoparticles destroy the flu virus. This process can be observed in an electron microscope after 30-minute incubation. The studies were conducted by specialists from Novosibirsk State University, State Scientific Center of Virology and Biotechnology *Vektor*, G.K. Boreskov Institute of Catalysis, RAS (Siberian Branch) and Institute of Chemical Biology and Fundamental Medicine, RAS (Siberian Branch).

A key health care problem is the search for efficient drugs made from ingredients that are harmless for humans and for the environment. One option is titanium dioxide. Its suspension is known to kill bacteria and viruses. However this requires daylight or UV light. Until now, little was known about titanium dioxide's nanoform action on microorganisms.

Novosibirsk researchers obtained titanium dioxide nanoparticles sized 4–5 nm. Their effect on H3N2 flu viral particles was studied. This is ordinary flue (not bird or swine flu). Nanoparticles stuck to the external viral shell surface and caused it to rupture. After 30 minutes the destruction process increased, and after 1–5 hours the viral particles were completely destroyed.

Lipoproteides make up the viral shells. It cannot be ruled out that that titanium dioxide nanoparticles can cause cell death. This must be taken into account while developing nanoparticle-based drugs. Titanium dioxide nanoparticles can be used as a disinfectant.

Nanobiosolders

Scientists from Moscow State Institute of Electronic Engineering and DELTARUS science-and-production company have studied nanocomposite adhesives for laser welding biological tissues (or biosolders).

During operations surgeons use high-energy lasers to prevent scar formation. By selecting irradiation parameters, a surgeon can selectively act on biotissues. The goal is either to coagulate or to destroy undesirable cells. In these instances laser solders are used to weld tissues or organs. They absorb laser radiation, link wound edges, and increase suture strength. Typical laser solders are albumin colloidal aqueous suspensions. Albumin is a transport protein contained within human and animal blood serum and cytoplasm cells. Albumin addition enhances tissue adhesion by increasing break strength after welding. During welding, it can be heated for a long time, which helps inactivate hepatitis and HIV viruses. The protein's binding properties reduce inflammation and clot formation probability. And, finally, albumin is a commercially available raw material. Once produced, the prepared solders have a long shelf life.

Bovine serum albumin (BSA) used in laser sutures has the highest breaking strength.

Although laser welding replaces traditional wound stitching, it cannot always ensure the same strength level in the first few post-operative days.

For this reason, the scientists decided to study applications for laser solder based on BSA and carbon nanotubes. For biotissues, they selected bovine trachea cartilage and pig skin samples. Nanobiosolders gave a several-fold increase in the laser welded suture breaking strength compared to ordinary solders based only on albumin dispersion.

These findings showed that the laser nanosolders have good potential in application. Laser solder compositions proved to be heat and light resistant. They retain their qualities during long-term storage in open air. When used in biotissue laser sutures, biosolders based on BSA and carbon nanotubes increase their breaking strength several-fold compared to ordinary albumin aqueous dispersion solders. Solders based on albumin containing other carbon structures (soot or activated carbon) only served to deteriorate the laser suture strength. The authors concluded that in this case it is carbon nanotubes that play the key role in laser suture strengthening.

Virtual worlds for astronauts

Flight simulation is not only a game. It is also a serious business when dealing with pilot and astronaut training. Before docking to a real space station, it is a good idea to learn to do it in virtual reality. Mathematical software for these simulations was developed at the **Department of Mechanics and Mathematics, M.V. Lomonosov Moscow State University (MGU).** The software can be used with a holographic screen or a virtual reality helmet. The international space station and astronaut's rescue devices play the mobile objects' role.

This unique space and aeronautical experience accumulated by MGU mathematicians was used to produce a mobile vertical pose simulator. This simulation is needed for developing and testing vestibular apparatus prosthetic devices. These devices help people with vestibular apparatus disorders restore their spatial orientation. Further, the scientists verified the concept for developing micro-electromechanical systems for personal spatial orientation for persons with sight disorders.

Active silt against pollution

Sadly, contaminated waste water is discharged into water bodies by both chemical and food industry facilities. The waste rich in organic matter hardly improve the ecological situation. **D.I. Mendeleyev Russian Chemical Technology University** has developed a new treatment method. It can be used with brewery wastes, phenol-containing, and fat-containing wastes. Active silt rich in microorganisms can remove contaminates. For more efficient operation, exposure to illumination and oxidation stress is recommended. Adding small hydrogen peroxide quantities can provide the needed stress. Under these conditions active silt kills 95-99 % organic contaminants.

The method developed is a single-stage process that can be used for biologically treating industrial waste water rich with organic matter. This technology reproduces the self-purification processes in natural lentic water bodies. A patent application was filed for the technology based on the research results. The authors plan to have the technology tested and approved by internationally.

New LED samples based on organic materials

Specialists from *P.N. Lebedev Physical Institute (FIAN)* have developed organic LEDs (OLED) based on metal-organic terbium and zinc complexes.

Recently there have been intensive developments in "alt-display" technology. The goal is a computer monitor made from OLEDs. Many laboratories are intensively studying new materials and looking for technology solution variants. Producing a LED based on a new material is a challenging and complex science and technology problem.

An area in this research field involves developing more universal materials. Attempts are made to combine several layer functions in one. The resulting small quality loss should be compensated by technology simplicity. The FIAN OLED group's significant advantage is the multifactor OLED degradation model they developed. It is primarily the organic matter time-dependent operation instability that limits its application.

FIAN has produced a pilot batch of low-molecular materials based on terbium and zinc.

A special material (ITO) layer is applied onto conducting glass (tin oxide and lead alloy). This layer is the transparent electrode. Several organic layers are vacuum-sprayed on it. They are made of a new synthesized substance (e.g., a complex compound formed by several Schiff bases added to the zinc atom). The cathode, a metal opaque layer, is deposited onto this multilayer amorphous film by thermal spraying. The resulting design looks like a capacitor – two electrodes with several organic layers compressed between them. Under tension, this LED prototype starts emitting light. In this way test samples – a few future display pixels – are made. These samples undergo comprehensive examination. This is done to adjust synthesis and achieve required parameters for the new material. This is a step-by-step iterative operation.

The objective is not only to develop a simple working structure. It is also to achieve efficiency that is higher than existing materials. Improvement may involve all or only some parameters.

Zinc complexes are not regarded as a material for lighting sources. This compound's characteristics related to quantum effects cannot yield a photoluminescence output that is higher than 25 %. But they have thermal stability and can stand high currents. However terbium materials' photoluminescence efficiency can be as high as 100 %. FIAN samples' efficiency is about 95 %. They release practically everything they have absorbed, while slightly changing the wavelength. Terbium materials have good prospects for producing various displays and lighting fixtures. Future and more efficient LEDs based on terbium metal-organic complexes may be the next step in optoelectronics and oust current LEDs based on inorganic materials.