Nanogyri of polyurethane brain

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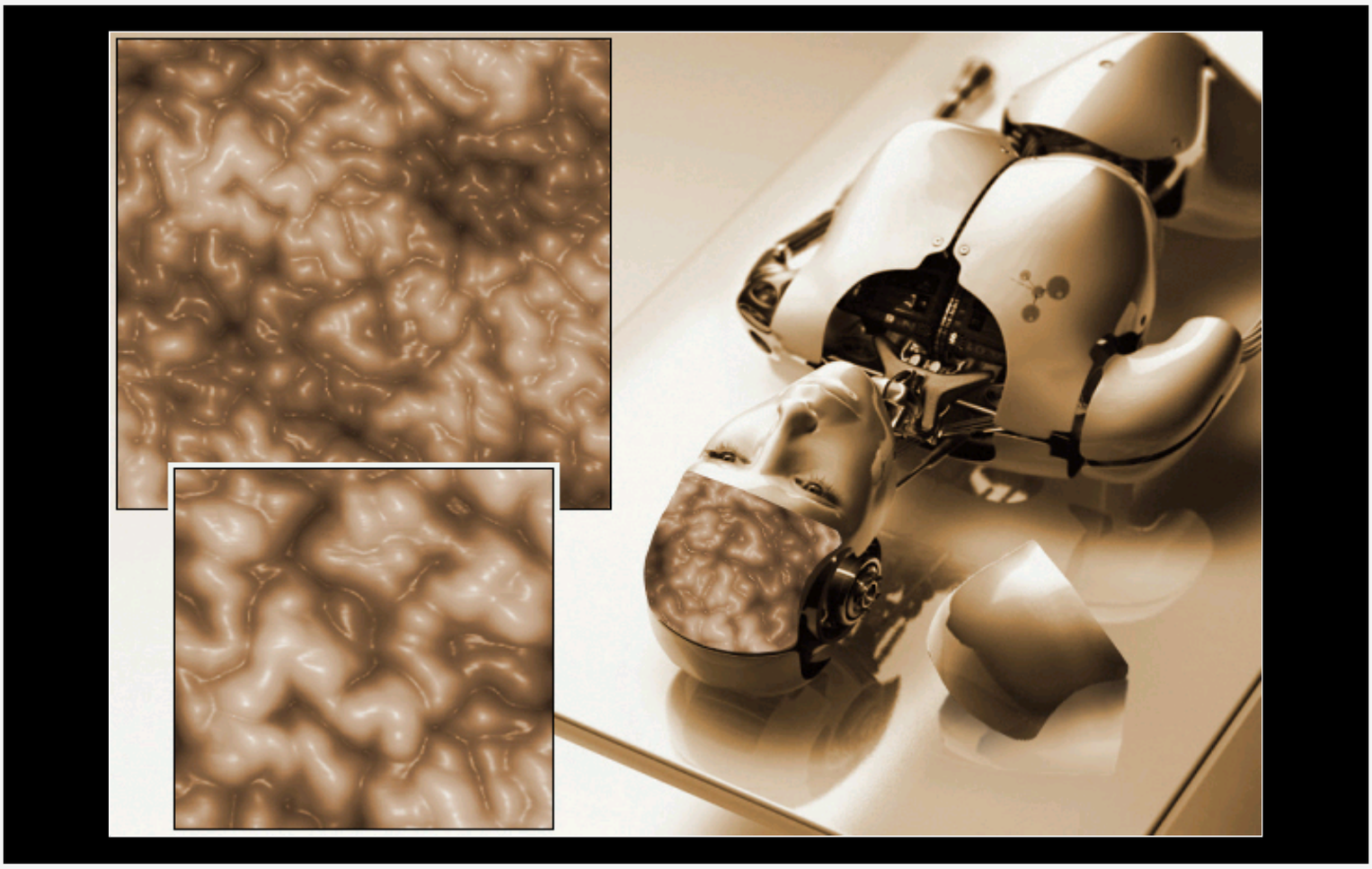

A surface resembling the gyri of a human brain is obtained after deposing a nanometer thick carbon film on a polyurethane substrate. The carbon film deposition is carried out by using the technique of pulsed arc plasma sputtering of a graphite target. During the deposition, the carbon film gets shrinked causing a deformation of the smooth surface of the polymer. As a result of the deformation, “nanogyri” are formed that have 73 nanometers in mean width and 13 nanometers in mean height.

Due to its chemical inertness, polyurethane is widely used as material for artificial organs (implants), viz. ventricles of artificial heart, vascular prostheses, articular cartilage, artificial skin, prostheses of esophageal, tracheal, etc. Deposition of thin carbon films allows for changing physicochemical properties of the polymer surface according to the practical demands or, as some say, modifying the polymer surface.

For example, the original polyurethane surface is hydrophobic, i. e., it is poorly wettable with water, water-repelling. In order to improve its biocompatibility, the polymer is coated with a thin amorphous carbon film, which allows for increase in moistening, i. e., makes the polymer surface to be hydrophilic. Moreover, the film coating forms a nanotopography, which improves cell attachment to the surface.

The recent studies have shown that stem cells differentiate into nerve ones after putting them on scaffolds of polyurethane nanofibers. Roughening the nanofiber surface with “nanoconvolutions” can improve the conditions for attachment of the growing nerve cells. In the suggested approach, the polyurethane nanofibers serve as a high-porous support that the nerve tissue is forming on. Moreover, as this tissue is forming, the nanofibers are being gradually resolved. The obtained nerve tissue can be used for repair and rehabilitation of damaged areas of a human brain. In the distant future, the suggested method may serve as a base for creation of a prototype brain of a cybernetic organism.

The images of the carbon-modified surface of polyurethane were taken with the atomic-force microscope Solver™ P4 (NT-MDT Co., Russia) in air in tapping mode. Silicon cantilever (Institute of Physical Problems named after F. V. Lukin, Russia) with force constant 12 N/m and resonance frequency 139 kHz was used, curvature radius of the probe made 10 nm. The size of the surface area at the background is 1.1×1.1 μm², at the foreground - 550×550 nm². The carbon film was deposited on polyurethane “Vitur” (Institute of Synthetic Resins, Russia) using the pulsed arc plasma system UVNIPA-1 (Plant “Quartz”, Russia) in vacuum $7.5 \cdot 10^{-4}$ Torr; pulse-repetition rate made 0.1 Hz, number of pulses was 50.

The experimental results were obtained in collaboration with Aleksey G. Kirilenko, Senior Researcher from the Institute of Physical Problems. The original image of the robot was courteously provided by Benedict Campbell, Photographer & Digital Artist. The author is also grateful to Oleg E. Lyapin, Software Engineer and to Lily V. Lapshina, Digital Designer for help in preparation of this artwork.