Surface characteristics influence cellular growth on semiconductor material

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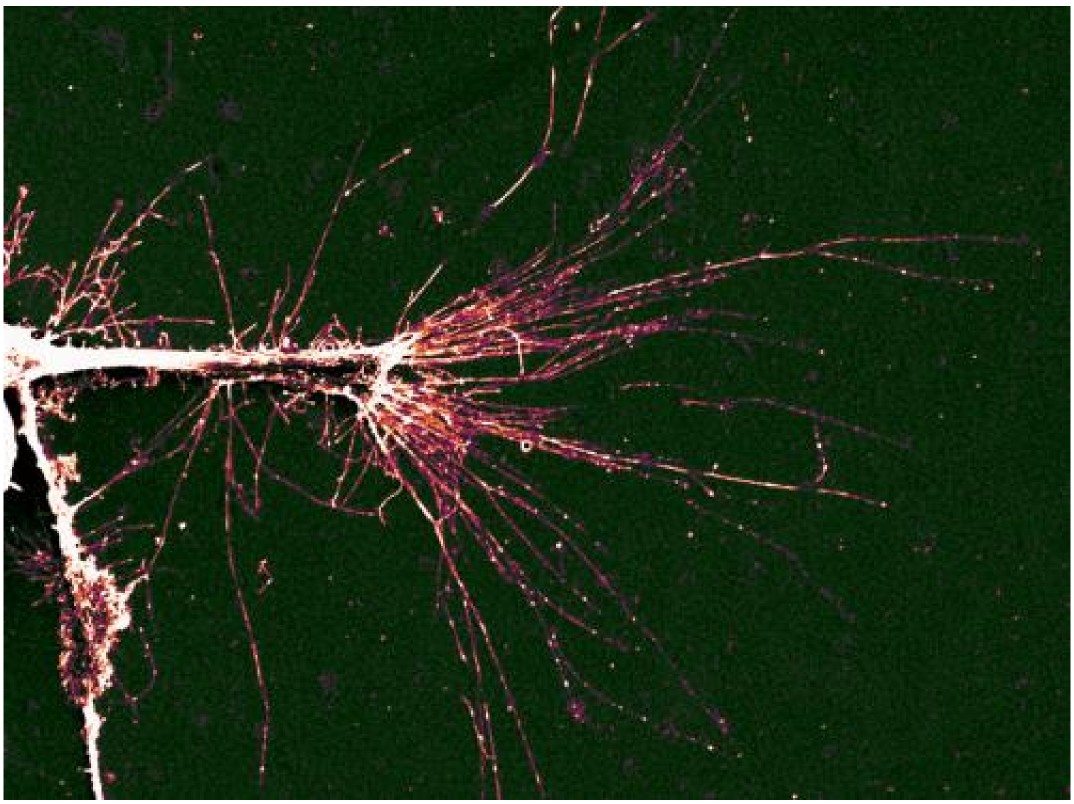

Changing the texture and surface characteristics of a semiconductor material at the nanoscale can influence the way that neural cells grow on the material. The PC12 cells in this image are growing abnormally -- spreading in all directions -- because they are on a randomly textured GaN surface. Credit: Lauren Bain

(Phys.org) —Changing the texture and surface characteristics of a semiconductor material at the nanoscale can influence the way that neural cells grow on the material.

The finding stems from a study performed by researchers at North Carolina State University, the University of North Carolina at Chapel Hill and Purdue University, and may have utility for developing future neural implants.

"We wanted to know how a material's texture and structure can influence cell adhesion and differentiation," says Lauren Bain, lead author of a paper describing the work and a Ph.D. student in the joint biomedical engineering program at NC State and UNC-Chapel Hill. "Basically, we wanted to know if changing the physical characteristics on the surface of a semiconductor could make it easier for an implant to be integrated into neural tissue – or soft tissue generally."

The researchers worked with gallium nitride (GaN), because it is one of the most promising semiconductor materials for use in biomedical applications. They also worked with PC12 cells, which are model cells used to mimic the behavior of neurons in lab experiments.

In the study, the researchers grew PC12 cells on GaN squares with four different surface characteristics: some squares were smooth; some had parallel grooves (resembling an irregular corduroy pattern); some were randomly textured (resembling a nanoscale mountain range); and some were covered with nanowires (resembling a nanoscale bed of nails).

Very few PC12 cells adhered to the smooth surface. And those that did adhere grew normally, forming long, narrow extensions. More PC12 cells adhered to the squares with parallel grooves, and these cells also grew normally.

About the same number of PC12 cells adhered to the randomly textured squares as adhered to the parallel grooves. However, these cells did not grow normally. Instead of forming narrow extensions, the cells flattened and spread across the GaN surface in all directions.

More PC12 cells adhered to the nanowire squares than to any of the other surfaces, but only 50 percent of the cells grew normally. The other 50 percent spread in all directions, like the cells on the randomly textured surfaces.

"This tells us that the actual shape of the surface characteristics influences the behavior of the cells," Bain says. "It's a non-chemical way of influencing the interaction between the material and the body. That's something we can explore as we continue working to develop new biomedical technologies."

More information: The paper, "Surface Topography and Chemistry Shape Cellular Behavior on Wide Band-Gap Semiconductors," is published in *Acta Biomaterialia*. www.sciencedirect.com/science/ … ii/S1742706114000907

Abstract: The chemical stability and electrical properties of gallium nitride have made it a promising material for the development of biocompatible electronics, a range of devices including biosensors as well as interfaces for probing and controlling cellular growth and signaling. To improve the interface formed between probe material and cell or biosystem, surface topography and chemistry can be applied to modify the ways in which the device interacts with its environment. PC12 cells are cultured on as-grown planar, unidirectionally polished, etched nanoporous, and nanowire GaN surfaces with and without a physisorbed peptide sequence that promotes cell adhesion. While cells demonstrate preferential adhesion to roughened surfaces over as-grown, flat surfaces, the topography of that roughness also influences the morphology of cellular adhesion and differentiation in neurotypic cells. Addition of the peptide sequence generally contributes further to cellular

adhesion and promotes development of stereotypic long, thin neurite outgrowths over alternate morphologies. The dependence of cell behavior on both the topographic morphology and surface chemistry is thus demonstrated, providing further evidence for the importance of surface modification for modulating bio-inorganic interfaces.

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