

## Two-Dimensional Morphological Gradients for Cell Biology

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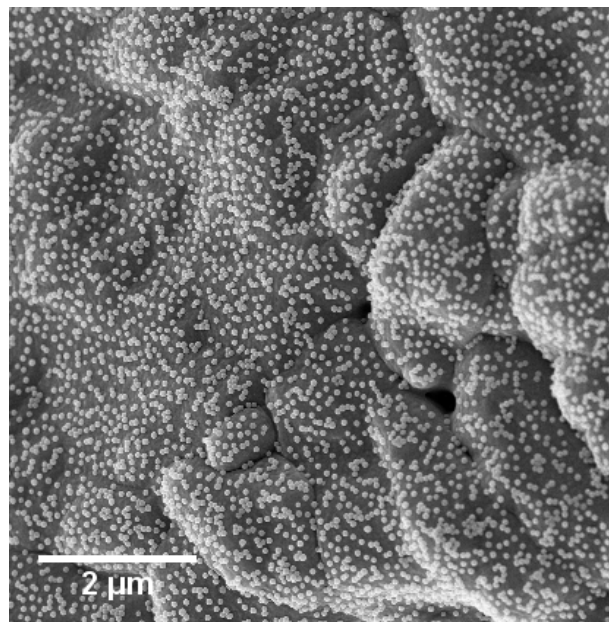
**INTRODUCTION:** Surface roughness plays an important role in contact-related phenomena, such as tribology or adhesion. Also, roughness plays a crucial role in the biological response to a surface, i.e. cell adhesion, morphology, proliferation and differentiation. Two methods were developed in our lab to create morphological gradients on a micrometre and on a nanometre scale. Additionally a combination of the two is used to create two-dimensional orthogonal roughness gradients varying in feature size along the two axes.

**METHODS:** Micro-featured gradients can be produced by using a two-step process: First aluminium substrates are sandblasted, followed by gradually polishing the rough surface with a chemical polishing solution. Cell experiments with these gradients have shown that with increasing roughness, rat calvarial osteoblasts (RCO) have a significantly higher proliferation rate<sup>1</sup>.

The nanoparticle-density gradient can be fabricated by kinetically controlled adsorption of negatively charged silica particles onto a positively charged, polyethylene-imine-(PEI) coated substrate. A subsequent sintering process results in a firm attachment of the particles and the removal of the PEI. RCO cell experiments on these gradients showed a significant decrease in proliferation with increasing particle density on the surface<sup>2</sup>.

To combine these two techniques, an alumina replica of the micro-featured gradient is made in order to withstand the high temperatures required during the particle-attachment process.

**RESULTS:** Figure 1 shows an SEM micrograph of an alumina replica with silica nanoparticles attached to it at a very high density. The two different roughnesses can clearly be distinguished: The nanoparticles add roughness in the nanometre length scale and the alumina grains, along with the waviness of the substrate, add features in the micrometre range.



*Fig. 1: SEM micrograph of silica nanoparticles on alumina roughness gradient.*

**DISCUSSION & CONCLUSIONS:** These newly created, two-dimensional gradients are an excellent choice to study the influence of surface roughness on cell behaviour. They not only cover features from the nano- to the micrometre length scale, but also numerous combinations of the two.

**REFERENCES:** <sup>1</sup>Kunzler T. P., Drobek T., Spencer N. D., *Applied Surface Science*, 253 (2006) 2148-2153, <sup>2</sup>Huwiler C., Kunzler T. P., Textor M., Vörös J., N. D. Spencer, *Langmuir*, 2007, 23 5929-5935

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