Nano-notch sends self-assembling polymers into a spiral

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A simple circular or hexagonal pit written into silicon can be used to generate self-assembling polymer spirals thanks to the addition of a tiny notch in the template, report scientists in the launch issue of *Nano Futures*.

What's more, modifying the notch's shape allows users to dial-up the direction of the spiral to generate either left- or right-handed patterns, and even create double spirals.

Nano- and micro-patterned substrates open the door to a range of applications from chemical sensing to data storage, but complex shapes can sometimes be difficult to generate quickly, and in large numbers. One way around this is to use materials—in this case, diblock copolymer thin films—that can self-assemble or rearrange themselves in response to easy-to-make templates such as circular or notched pits.

"The notch breaks the symmetry giving control over the spiral direction," explained Caroline Ross from Massachusetts Institute of Technology, US, who led a team-effort involving colleagues on campus as well as scientists based in Korea and Singapore.

Understanding how to program the direction of the spiral is important as the feature could be used to convey 'handedness' (chirality) in an analytical device – for example, to configure substrates that are sensitive to chiral arrangements such as DNA, amino acids and proteins.

In the study, the group—which includes researchers Hong Kyoon Choi, Jae-Byum Chang, Adam Hannon, Joel Yang, Karl Berggren and Alfredo Alexander-Katz – used a mathematical model to reproduce the curved morphologies observed in their experiments.

"We wanted to understand the formation of spirals in more detail, what controls their chirality, and the competition between spirals versus concentric rings," added Ross.

Without the notch, depositing polymer into circular pits (with an inner diameter of 350 nm) produced a set of four concentric rings in each of the miniature templates. But with the feature, spiral patterns were established instead.

Simulations allowed the team to explore how the confining geometry leads to the formation of such ring-shaped or spiral microdomains. In the work, the researchers note that a spiral arrangement avoids the energetic costs associated with strain in concentric rings (which would be distorted due to the presence of the notch).

Further analysis by the team identified the effect of making the notch slimmer or wider and also what happens when non-circular pits are used.

Full details can be found in the journal *Nano Futures* – a new title publishing fundamental and applied research at the forefront of nanoscience and technological innovation.

More information: Hong Kyoon Choi et al. Nanoscale spirals by directed self-assembly, *Nano Futures* (2017). DOI: 10.1088/2399-1984/aa641c

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