Liquid-Crystalline Analogues of the Abrikosov Vortex Structures Induced by Adaptive Targeting Nanoparticles

George Cordoyiannis and Maja Trcek
Condensed Matter, Jozef Stefan Institute, Ljubljana, Slovenia

Samo Kralj
Faculty Natural Sciences and Mathematics, University of Maribor, Maribor, Slovenia

Vasilis Tzitzios
Institute of Materials Science, National Centre for Scientific Research "Demokritos", Aghia Paraskevi, Greece

George Nounesis
Institute of Radioisotopes and Radiodiagnostic Products, National Centre for Scientific Research "Demokritos", Aghia Paraskevi, Greece

Jan Thoen
Departement Natuurkunde en Sterrenkunde, Katholieke Universiteit Leuven, Leuven, Belgium

Zdravko Kutnjak [C, S]
Condensed Matter, Jozef Stefan Institute, Ljubljana, Slovenia
zdravko.kutnjak@ijs.si

It is demonstrated that interactions between nanoparticles and topological defects induce a twist-grain boundary phase in chiral liquid crystals [1,2]. The occurrence of this phase, the analogue of the Shubnikov phase in type-II superconductors, is driven by direct interactions between surface-functionalized CdSe quantum dots and screw dislocations. It is shown that, within an adaptive-defect-core-targeting mechanism, nanoparticles of appropriate size and functionalization adapt to qualitatively different cores of topological defects such as disclination lines and screw dislocations. This mechanism enables the effective reduction of the energetically costly, singular defect core volume, while the surrounding phase ordering remains relatively weakly affected. The findings suggest new pathways towards the controlled assembly of superstructures in diverse, symmetry-broken, condensed-matter systems, ranging from nanoparticle-decorated liquid crystals to superconductors.

References

[1] G. Cordoyiannis et al., Soft Matter, vol. 9, 3956 (2013). [2] M. Trček ert al. Phys. Rev. E, vol. 90, 032501 (2014).