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Editorial corner – a personal view
Polymers and polymer composites as ideal systems for testing and understanding 'dissipative structures'?

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Ilya Prigogine, the Russian-Belgian scientist who received Nobel Prize for his research in the field of chemical thermodynamics in 1977, coined a much discussed and debated phrase, that of 'dissipative structures'. Such structures emerge in far from equilibrium systems and are able to form spatially or temporally ordered structures from the previously chaotic state of the same system. As described in his famous and popular book (Order out of Chaos, co-authored by I. Stengers, ISBN-10 0553343637) dissipative structures are formed spontaneously by large scale fluctuations and the properties of the resulting ordered systems are presumably determined (or at least influenced) by the peripheral conditions. Well known examples include the Benard instability in convective heat conduction, the Belousov-Zhabotinsky reaction and several others. The implications are enormous, especially with respect to early biogenesis, which, according e.g. to the chemoton model of T. Gánti (ISBN 9780306477850) is related to the formation of self-regulating autocatalytic chemical super-cycles. In spite of the popularity of the idea in the 1980's no systematic theory was suggested which could explain how the peripheral conditions influence the emerging structures and how can one predict such structures from the initial conditions.

It seems natural to use polymers and their composites as model systems to test such a theory. It is interesting to note that already in 1977 a dissipative structural theory was suggested to describe the glass transition phenomenon (https://doi.org/10.1002/pol.1979.180171112), and, recently the formation of various crystalline forms, such as shish-kebab structures (https://doi.org/10.1107/S205225251402288X) was also interpreted in this theoretical framework. Wessling offered a complex theory with semi-quantitative estimations to describe the ordered structure formation in conductive polymer composites already in 1991 (https://doi.org/10.1016/0379-6779(91)91798-F), which was later complemented by model calculations (https://doi.org/10.1051/jp2:1996184), while others compared the self-assembly and dissipative structure formation in metal nanoparticle – polymer composites (https://doi.org/10.1007/978-3-319-19410-3_1). Self-oscillating polymer gels (https://doi.org/10.3390/ijms131216281; https://doi.org/10.1038/am.2014.32) are especially relevant models for biological systems, while some theoretical considerations on the Frölich condensation of Bose-Einstein quantum systems seem to be relevant to the information processing in biological macromolecules (https://doi.org/10.3390/info3040601).

It is time now to utilize the wide range of polymer chemistry tools available (e.g. synthesis methods for complicated molecular architectures, high speed molecular dynamics calculations) to explore the possibilities of this old hypothesis and to try to understand the laws governing the formation of dissipative structures in polymers under various initial and peripheral conditions. It may give unified answers to several phenomena treated now using different physical models.

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