Dynamic assembly of nanomaterials into fiber

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One classic strategy for functional fibre is to combine nanomaterials and a thermoplastic/thermoset matrix. Relatively low performance examples based on thermoplastics exist and provide model systems for studies of the critical constituent parameters. To create high performance embodiments, high surface area, strength and unprecedented features should be considered; these fibres will ultimately be combined with the specifically-designed polymeric matrices. State-of-the-art, high performance constituents, based on nanomaterials, have an essentially static structural framework that fails irreversibly without any dynamic response. We propose to re-engineer the constituents to allow a dynamic response to stimulus without irreversible loss of mechanical performance as a fibre. To enable this approach, molecular interactions must respond at the certain levels and timescales without losing their features at the nanoscale. Recent advances in the chemistry of complementary nanomaterials will provide the means to adjust the strength of the interactions. For optimal performance, the constituents will need to be redesigned from the bottom up; however, in many cases, existing materials can be adapted by integrating new, dynamically responsive links, as part of the matrix structure. Whilst we are not intending to follow an explicitly classical approach, it is worth noting that most tough and strong fibre systems integrate liquid crystalline materials with soft, dynamic molecular phases. Our strategy is to introduce strong dynamic (reversible) interactions in a variety of length scales and geometries, in order to explore new strategies for the fabrication of functional fibres.

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