Macromolecules, Assemblies, Particles – A Discovery Journey in Materials Synthesis

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Four different cases of unique functional nanoparticles are made and compared from a structural and functional viewpoint:

- Latices from (water free) oil-in-oil emulsions,
- Shape-persistent dendrimers,
- Surface functionalized globular proteins and
- Carbon nanoparticles and nanocomposites

In all cases new synthetic concepts are required such as:

- Stabilizing oil-in-oil droplets as reaction vessels by specially designed amphiphilic copolymers, thus yielding, e.g., porous polyurethane particles,
- Synthesizing structurally perfect and monodisperse dendrimers with molecular weights above 500,000 Da,
- Transforming proteins such as bovine serum albumin into core-shell polyelectrolytes,
- Obtaining carbon particles by precursor defined and template-assisted pyrolysis.

The length scales can be further extended and the structural complexity increased by allowing self-assembly yielding for example non-spherical monodispersed dendrimer aggregates in the Megadalton domain or complex stoichiometries of polyelectrolyte-polyelectrolyte complexes. These new particles offer a broad range of highly sophisticated applications such as gene transfection, catalysis (polyolefin synthesis, styrene synthesis, oxygen reduction), lithium storage or sensing technologies.

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