Layer-by-Layer Modification of Self-Assembled Nanotubes from Amino Acid Amphiphiles in Solution

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Nanotubes with a well-defined radius can be formed by self-assembly of amino acid amphiphiles (AAAs, short synthetic peptides generated from amino acids and fatty acids). The self-assembly of the AAA K:C_{12}-β_{12} (*N-α*-lauryl-lysyl-aminolauryl-lysyl-amide) has been studied to some extent [1]. It self-assembles into stable nanotubes of great length (up to several µm) and a diameter of 70-100 nm by progressing from long thin fibers via twisted and helically coiled ribbons to nanotubes [2]. Systematic modification of the chemical structure of AAAs will improve the understanding of the molecular factors essential to nanotube formation and increase the understanding of the process kinetics.
Recent experiments have shown that such AAA nanotubes, which are naturally charged depending on pH, can be used as templates to form a polyelectrolyte layer of opposite charge around them [3]. Multi-layered nanotubes can be produced by subsequent deposition of oppositely charged materials, e.g. polyelectrolytes, on the nanotube surface, i.e. by applying the layer-by-layer (LbL) technique [4]. Accordingly we study the structural details of AAA nanotubes modified by the addition of different polyelectrolytes and for an increasing number of deposition steps in aqueous solution combining different techniques like scattering methods (SLS/DLS, SANS, SAXS), AFM and direct-imaging methods (cryo- and dry TEM, SEM). From the various information provided by these methods a comprehensive understanding of structural details of the modified nanotubes can be gained where pH and surface charge are expected to be major control parameters. The polyelectrolyte modification yields hybrid nanotubes with potentially adjustable properties rendering these systems much more versatile for employment in future applications, e.g. in delivery systems and as smart materials.

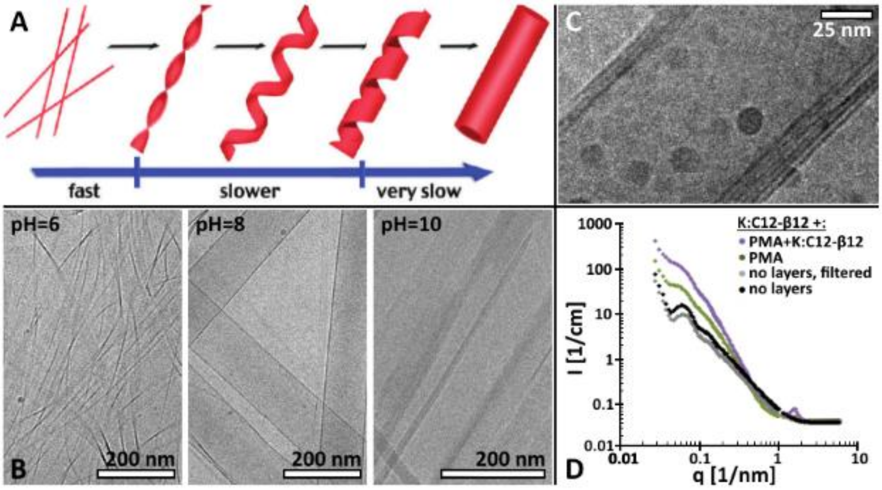

Figure 1: A: Schematic illustration of the self-assembly route of K:C_{12}-β_{12} in aqueous solution [from 2], **B:** pH-dependent self-assembly of K:C_{12}-β_{12} in water, **C:** Multi-layered nanotube produced by layer-by-layer (LbL) deposition of poly(methacrylic acid) (PMA) and K:C_{12}-β_{12} on aged nanotubes of K:C_{12}-β_{12}, **D:** Neutron scattering curves of LbL-modified solutions of K:C_{12}-β_{12}.

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