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Chitosan-based colloidal polyelectrolyte complexes: Safe and green drug/vaccine nano-delivery systems

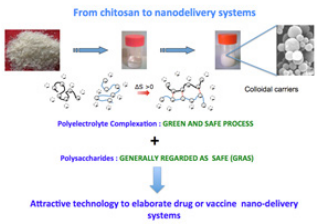
Drug Delivery Systems (DDS) prove essential for a better efficacy and safety of the chemotherapies and that fight diseases and improve the quality of life of patients.

The efficiency of DDS lies in their capabilities at delivering the right amount of an Active Pharmaceutical Ingredient (API), at the right location in the body, in the safest manner and more comfortable way for the patients. Moreover, DDS should be efficiently manufactured *via* robust, green and low cost processes involving the use of raw materials complying with a sustainable development. Hence, new generations of DDS will need a global and multidisciplinary approach, addressing the above-mentioned challenges.

Here, we report on our strategy of DDS elaboration, using polyelectrolyte complexes (PECs) of biosourced polysaccharides leading to tailored and multifunctional nanodelivery systems.

PECs result from the self-assembly of oppositely charged polymers in water. During the charge neutralization step, counter-ions and water molecules are released, inducing a gain in entropy of the system. Therefore, PECS formation is spontaneous, energy efficient as it takes place in water under mild experimental conditions, without needing high shear rates nor organic solvents. In that sense, polyelectrolyte complexation is a safe and green process. When this process is used with biosourced polysaccharides, generally regarded as safe, we have at hand a formulation process that meets many of the above requirements.

We will establish that by a precise control of the physico-chemistry properties of chitosan, and also of the parameters of the assembly (for example by switching the assembly from a kinetically controlled to a more thermodynamically controlled process) we produced carriers featuring a fair colloidal stability in physiological media, a capacity at encapsulating molecular drugs and at interacting with macromolecules like proteins, either for targeting purposes or for inducing appropriate immune responses for vaccine delivery purposes.



Recent Publications

1. Faivre J, Sudre G, Montembault A, Benayoun S, Banquy X, Delair T, David L, (2018) Bioinspired microstructures of chitosan hydrogel provide enhanced wear protection, Soft Matter 14(11) 2068-2076.
2. Wu D, Ensinas A, Verrier B, A. Cuvillier A, Champier G, Paul S, Delair T. (2017), Ternary polysaccharide complexes: Colloidal drug delivery systems stabilized in physiological media, Carbohydrate Polymers 172 265-274.876.
3. Wu D, Ensinas A, Verrier B, Primard C, Cuvillier A, Champier G, Paul S, Delair T. (2016) Zinc-stabilized colloidal polyelectrolyte complexes of chitosan/hyaluronan: a tool for the inhibition of HIV-1 infection. Journal of Materials Chemistry B.;4:5455-63. .
4. Lalevee G, Sudre G, Montembault A, Meadows J, Malaise S, Crepet A, David L, Delair T, (2016) Polyelectrolyte complexes *via* desalting mixtures of hyaluronic acid and chitosan-Physicochemical study and structural analysis, Carbohydrate Polymers 154 86-95530.
5. 5. Costalat M, Alcouffe P, David L, Delair T, (2015) Macro-hydrogels versus nanoparticles by the controlled assembly of polysaccharides, Carbohydrate Polymers 134 541-5461.

Biography

Thierry Delair is full professor at Claude Bernard University, Lyon 1, since November 2008. Before, he spent 20 years in different R&D departments in the bioMérieux group where he developed polymers for *in vitro* medical diagnostics and nanodelivery systems for sub-unit or DNA vaccines. He supervised 26 PhD students, numerous trainees and postdoctoral students. He published 155 articles in international peered-reviewed journals (h-index =34 ,number of citations 3855), filed 22 patents, participated in 8 book chapters, and gave 62 oral conferences (12 as invited speaker). His results allowed the creation of three companies: Ademtech (Pessac, France), producing magnetic particles, Anabior (Saint Ismier, 38), pharmaceutical society specialized in the production of particles-based adjuvants for vaccines and CYTOSIAL Biomedic (Lyon) a cosmetics company.

His current research activities are focused on the elaboration and the characterization of nano-structured physical hydrogels based on polysaccharides for tissue engineering applications, drug or vaccine delivery.

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