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A NOVEL METHOD TO STUDY MECHANICAL PROPERTIES OF POLYELECROLYTE MICROCAPSULES

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INTRODUCTION: Polyectrolyte multilayer capsules have been recently introduced as a novel type of nano-engineered microstructures[1]. These capsules are made by layer-by-layer adsorption of oppositely charged polyelectrolytes onto charged colloidal particles with subsequent removal of template core. The relatively easy way of preparation, well-defined shape, and mechanical stability allows their use for such applications as encapsulation of a wide class of molecules, drug delivery or biomimetics.

METHODS: We present a novel approach to study the properties of polyelectrolyte microcapsules which is based on measurement the load-deformation curves of capsule with the Atomic Force Microscope (AFM) related device combined with the laser scanning confocal microscope. Capsule deformed by using piezo manipulator between the flat surface and the big sphere glued on the AFM cantilever. AFM allows us to see the deformation force, and optical or confocal microscope - the shape of capsule (Fig. 1).

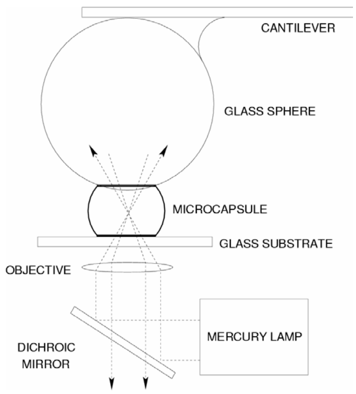

Fig. 1: Schematic picture of the experiment.

RESULTS: Figure 2 shows a typical confocal image of a polyelectrolyte capsule (left) and force-deformation curve (right).

For a small deformation (ε) simple model can predict dependence between force **F** and deformation ε :

$$F = 2\pi \frac{E}{1-\nu} hR\varepsilon^3$$

where **R** is radius the of capsule, **h** – wall thickness, **E** – elastic modulus of the capsule shell and ν- its Poisson ratio. Fitting to the load-deformation profile allows us to determine the Young's modulus of polyelectrolyte multilayer structure (for Poisson ratio of 0.5). It is varies from 5 MPa in the case of melamine formaldehyde (MF) core to 0.3-0.5 for latex core which have got the same order of magnitude with high-elastic polymers[2].

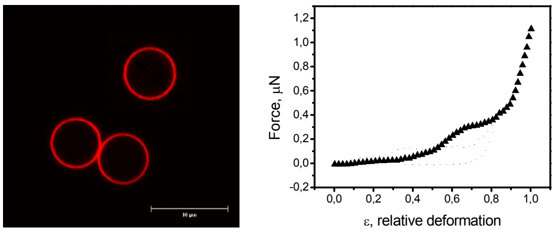

Fig. 2: Hollow polyelectrolyte capsules (left) and their typical load-deformation profile(right).

Hollow capsules were filled with polymer and the same method already presented to study them. It allow us to find the structure of inner polymer network[3] add diffusion properties of polyelectrolyte shell[4].

DISCUSSION & CONCLUSIONS: Our method gives us information about the mechanical and adhesion properties of capsules. Permeability of polyelectrolyte shells and Young modulus of polyelectrolyte multiplayer can be easily obtain. Some extension of this method can be used for characterization micro- and nanoparticles, ultrathin membranes, vesicles and cells.

REFERENCES: [1]Donath, E.; Sukhorukov, G. B.; Caruso, F.; Davis, S.; Möhwald, H. *Angew. Chem. 1998, 110, 2323.* [2]V.V.Lulevich, D.Andrienko, and O.I.Vinogradova. Elasticity of Polyelectrolyte Multilayer Microcapsules, Phys. Rev. E (submitted). [3]V.V.Lulevich, I.L.Radtchenko, G.B.Sukhorukov, and O.I.Vinogradova., *J. Phys. Chem. B, 2003, V.107, N.11, p.2735-2740.* [4]V.V.Lulevich, I.L.Radtchenko, G.B.Sukhorukov, and O.I.Vinogradova, *Macromolecules 2003, 36, 2832-2837.*

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