MIXED ADSORPTION LAYERS OF CHITOSAN AND COLLAGEN

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Collagen and chitosan are promising materials because of their unique biological and manufacturing properties. Chitosan can affect the self-assembly process of collagen through electrostatic interactions. Chemical crosslinking provides new opportunities for obtaining biodegradable materials with well-defined microarchitecture and mechanical properties. In this work we apply this approach based on the simultaneous use of chitosan, collagen type I, and glutaraldehyde (GA) as a cross-linker for obtaining thin layers at the air–water interface with controlled morphology. The properties of the layers were studied using the oscillation ring method, ellipsometry, and atomic force microscopy (AFM). The properties of the composite films strongly depend on the ratio between components, pH, and the presence of the cross-linker. At pH 2, both chitosan and collagen possess a positive charge and almost do not interact. The dynamic surface elasticity, dynamic surface tension, and the adsorbed amount for the mixed systems change from the values typical for one component to those typical for the other, regardless of the presence or absence of GA. However, AFM images demonstrate various types of morphology and a significant impact of GA on the layer structure. When chitosan dominates, one can see numerous islands consisting of short rods. They can transform into a coral-like structure with a clearly noticeable center of growth under the influence of GA. When the main component is collagen, numerous dots are observed. At a ratio of 1:1, the surface layer consists of aggregates of complex shape, which turn into a structure resembling roof tiles when GA is added.

At pH 6, both chitosan and collagen separately demonstrate relatively weak surface activity. However, the complexes of collagen and chitosan show a significant surface activity. At a ratio of 1:1, the dynamic surface tension reaches about 57 mN/m at equilibrium, as compared to 71 and 70 mN/m for pure chitosan and collagen, respectively. The dynamic surface elasticity of the mixtures is in between the values for pure components and ranges from 20 to 30 mN/m, depending on the component ratio. GA addition at a concentration of 0.2 mg/ml results in a significant increase in the dynamic surface elasticity, up to 200 mN/m, and thge film thickness, up to 30 nm. On the basis of AFM data, we can expect the formation of a continuous structure where both components are connected into a single network. Probably the elementary building blocks of this network are the collagen microfibrils, which were observed for collagen–chitosan mixtures without GA. It can be suggested that the addition of the cross-linker allows the formation of a chitosan shell on the surface of the fibrils, connects them, and thus improves the mechanical properties of the adsorption layer.

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