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Adsorption Layer Formation in Dispersions of Protein Aggregates

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Abstract

The review discusses recent results on the adsorption of amyloid fibrils and protein microgels at liquid/fluid interfaces. The application of the shear and dilational surface rheology, atomic force microscopy and passive particle probe tracking allowed for elucidating characteristic features of the protein aggregate adsorption while some proposed hypothesis still must be examined by special methods for structural characterization. Although the distinctions of the shear surface properties of dispersions of protein aggregates from the properties of native protein solutions are higher than the corresponding distinctions of the dilational surface properties, the latter ones give a possibility to obtain new information on the formation of fibril aggregates at the water/air interface. Only the adsorption of BLG microgels and fibrils was studied in some details. The kinetic dependencies of the dynamic surface tension and dilational surface elasticity for aqueous dispersions of protein globules, protein microgels and purified fibrils are similar if the system does not contain flexible macromolecules of flexible protein fragments. In the opposite case the kinetic dependencies of the dynamic surface elasticity can be non-monotonic. The solution pH influences strongly the dynamic surface properties of the dispersions of protein aggregates indicating that the adsorption kinetics is controlled by an electrostatic adsorption barrier if the pH deviates from the isoelectric point. A special section of the review considers the possibility to apply kinetic models of nanoparticle adsorption to the adsorption of protein aggregates.

Keywords: amyloid fibrils, protein microgels, liquid-fluid interfaces, adsorption kinetics, surface rheology

Introduction

A large number of recent reviews on formation, properties and applications of protein aggregates indicate a great current interest in this subject [1-12]. Although it is not a new research area and the protein aggregation, for example, in human body [5] or in mammalian milk [13, 14] has been studied for more than one hundred years, it has become clear only recently that this phenomenon is widespread in nature and can be successfully used for the production of new functional materials for medical and industrial applications [4, 5, 9-12].

Among various protein aggregates in nature amyloid fibrils have been probably of the greatest interest and most intensively studied. The term “amyloid” was firstly used by Rudolf Virchow to