

STRUCTURAL AND DYNAMIC ASPECTS OF PLASTICIZATION AND ANTIPLASTICIZATION IN CARBOHYDRATE GLASSES

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Carbohydrate glasses are widely used in the protection of active ingredients in pharmaceuticals and in foods. In the pharmaceutical domain, bioactive proteins and peptides are commonly stabilized by amorphous matrices based on the disaccharide trehalose [1], whereas in the food domain, oxidation-sensitive active ingredients, such as polyunsaturated fatty acids and essential oils are often encapsulated in matrices based on starch hydrolysates and sucrose [2]. In recent years, it has become clear that, whereas the glass transition of the glassy matrix is relevant for the protective properties of the amorphous matrix, the glassy-state structure and dynamics exert a controlling role as well, specifically in relation to the antiplasticization of the main constituent of the glassy matrix by low-molecular weight diluents [2]. In this lecture, I am reviewing experimental evidence for the antiplasticization and plasticization in carbohydrate glasses. I will first be discussing recent insights in impact of low-molecular weight diluents on the dynamics of the glassy matrix as probed by dielectric spectroscopy, neutron scattering and solid-state NMR [1, 3]. I will then turn to our recent insights in the dependence of the molecular packing of carbohydrate glasses on composition, pressure and temperature as determined by positron annihilation lifetime spectroscopy and volumetric measurements [2, 4]. Finally, I will attempt to link the regimes as identified via the structural and dynamic properties in order to formulate a general hypothesis for the mechanism of plasticization and antiplasticization of carbohydrate glasses by low molecular weight diluents.

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