339b Moisture Penetration into Sugar Glasses

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The main objective of this work was to quantify the penetration of water into a sugar glass. A one-dimensional diffusion experiment was developed where a sugar glass (3.5% water content) was made into a thin film on a microscope cell, with all edges but one sealed to allow controlled moisture penetration in one dimension. Samples were stored in controlled relative humidity (RH) of either 53, 75 or 89% and moisture penetration followed as function of time and distance from the exposed edge. To quantify moisture content at any point into the glass from the exposed edge and at any exposure time, an FT-NIR micro-spectroscopy method was employed. Quantification of water content by FT-NIR was done by taking the peak ratio of water to sugar for samples of known water content and generating a standard curve. The peak ratios measured at any point were correlated to a specific water content in this way. Because the spot size for the FT-NIR micro-spectroscopic method was about 20 microns, data was taken at approximately every 25 micron increment from the exposed edge, allowing quantification of moisture penetration over time. At the lowest storage RH, moisture penetration generally followed Fick's law, where the surface exposed to humid air gradually increased in moisture content during storage and the moisture content decreased approximately exponentially into the interior of the glass. However, at higher RH, a different pattern was observed. The surface moisture quickly rose to an equilibrium value (between the sugar and the air) and a high water content syrup layer was formed at the exposed edge. A very distinct penetration front was observed to slowly move into the interior of the glass. A simple Fick's law model of diffusion was found to be appropriate at low RH, whereas a more complex model of moisture penetration was needed at higher RH.