In situ study of maltodextrins particle surface properties by environmental Atomic Force Microscopy

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Powders are widely used in the food industry, mainly thanks to their ease of use, handling, transport, or even for their extended storage properties. Powders techno-functionalities (such as reconstitution) are highly depending on powder surface, as it is the first part in contact with the ambient environment. Environmental conditions are known to highly impact powder properties, especially with the glass transition, which make powder undergoes from a glassy to a rubbery state, completely changing powder surface properties. For the first time on food powders, environmental Atomic Force Microscopy (AFM) was used to probe single particle surface properties in real time by variating relative humidity (RH) and temperature. Maltodextrins are widely used in the food industry, as excipients, thickener, encapsulating agent, or even for flavor enhancement. They are hydrolyzed products derived from starch and generally classified depending on their polymer length chain thanks to the DE value. In this work, low, intermediate, and high DE value maltodextrins value were used as a model matrix to study in real time and on a same particle the impact of an increase in RH and temperature. Thus, humidity ramps from 20 to 80% at constant temperatures of 20 and 50°C and temperature from 20 to 50°C at a constant RH of 20 or 80% were performed. Thanks to AFM, surface topography, roughness, but also Young modulus distribution evolutions at the particle surface were studied in real time. Thus, it was shown that glass transition and RH seem to drive the particle surface properties. Indeed, glass transition was always accompanied by a large global surface smoothing, whatever the DE value. This surface smoothing was also accompanied by a large decrease of the surface roughness with the increase of the humidity. Finally, particles in the glassy state were relatively hard with a high and heterogenous Young modulus distribution, whereas it slightly decreased with the increase of the RH. An increase of the RH made the particle become progressively softer, while crossing the glass transition temperature made the particle become way softer. These results were useful to show that glass transition significantly impacts particle surface properties.