The Dynamics of Oil Uptake in Fried Foodstuffs using Synchrotron Radiation

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As ten to twenty-five percent of food products are fried before consumption, reducing oil uptake is a main concern in developed and developing countries. Fried products (French-fries, chips, nuggets…) are mainly appreciated for two unique properties of the crust: i) crispiness achieved by a rapid drying that freezes the structure in a fragile glassy state and ii) an oily taste induced by a partial oil wetting of the dried crust. When the product remains submerged in hot oil, friction losses of steam against the dried crust creates an internal overpressure that prevents oil from penetrating the product. During cooling, steam condensation and capillary forces drive oil to internal regions, where it replaces partly initial water. This work investigates the role of defects, cell damages on the percolation of oil through two model crusts representative of French-fries type and battered products (i.e. including a coating such as chicken nuggets).

Deep-UV excitation (280-290 nm) was used to monitor in time and in space the microscopic flow of oil through crusts (batter and potato) in conditions simulating the cooling step immediately after immersion frying. Experiments and simulations showed that the percolation of oil is a highly heterogeneous process not only in space but also in time. The connectivity of cells or defects controls the resulting oil uptake: penetration depth and transversal dispersion. The observed mixing of time scales to reach a given depth in the crust demonstrated the dominating role of viscous forces over capillary forces. In agreement with our observations and corresponding models, new strategies to reduce oil uptake at industrial scale are proposed.