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Synchrotron Radiation Studies On The Crystallization Of Edible Fats Under Shear

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Beamline(s): X10A, X10B

Introduction: The study of crystallization of edible fats under shear is of extreme importance for the oils and fats processing industry. The different crystalline polymorphs that these materials form are dependent on the temperature and shear history of the material. We conducted the first systematic study of the effect of shear on the crystallization of the three edible fats that constitute the majority of the world market, namely Cocoa Butter (used to manufacture chocolate), Milk Fat and Palm Oil.

Methods and Materials: Synchrotron radiation in NSLS line X10A was used together with a Bruker 2D detector to observe the diffraction patterns from samples sheared in a Taylor-Couette cell. The cell was equipped with a temperature control system that allowed us to program defined cooling rates and final temperatures. The samples were kept liquid at 50 ºC for 30 minutes and then cooled at 3 ºC/min to the desired temperature. Images were acquired continuously with an exposure time of 50 seconds.

Results: We discovered that the high shear (1440 s^{-1}) induces the formation of oriented crystallites in all the materials tested, including fine black chocolate. This orientation is absent in systems crystallized statically and at low shear rates (90 s^{-1}). We also discovered that the dramatic acceleration of the phase transitions between polymorphs occasioned by shear is a general behavior of all the fats studied.

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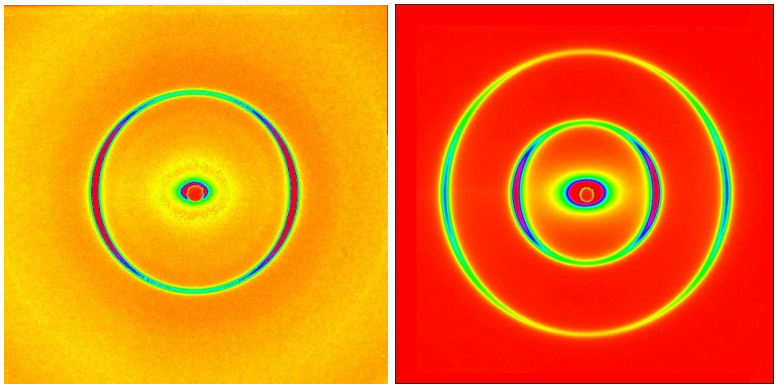

X-Ray diffraction patterns of the 001 plane of oriented Cocoa Butter crystallized under shear rate of 1440 s^{-1}. The first image is the β' form and the second is the β form.