Breath figures of two immiscible substances as a pathway to structure emulsions

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In this work, we report experimental results on the long term evolution of the Breath Figures BF) formed by vapors of two immiscible substances on a repellent substrate. The experimental setups comprising an open condensation chamber where the vapors are streamed at a controlled flow rate, wherein the substances are water and hexamethyldisyloxane (HDMSO) oil, which interact to each other during the BF evolution. At the beginning of each experiment it is observed that water condenses first and well after HDMSO does. This can be explained due to the difference of dew point temperature which delays the condensation of HMDSO vapor: water has higher dew temperature than HMDSO oil. Other factors could be the surface tension between the water vapor in the local atmosphere, and the surface tension respect the substrate of each substance. Therefore, the water droplet-pattern forms first and all the dynamics of this system depends on the amount of water condensed because the size of HDMSO oil droplets is limited to the empty spaces between water droplets, and time after, when the amount of HDMSO mass reaches certain occupation area, water and HDMSO interact to form chains and other soft arrangements with well-defined edges. These chains and arrangements could differ in size and in configuration depending on the saturation pressure of vapors flowed to the condensation chamber. We capture time series of digital images using a microscope and a magnification of 2X during the BF formation. Those digital images are processed with C++ routines with OpenCV's libraries. The main outcomes of this analysis are geometrical properties of the condensation patte (e.g. perimeter, centroid, area, eccentricity) Also a histogram of grayscale range is computed in local regions where the centroid of a droplet is detected and classified to distinguish whether observed droplets are made of water or oil. Time-resolved distributions of size of the complete droplet-pattern and separated water droplet-pattern and oil droplet-pattern are considered as inputs in the Smoluchowski's equation which is applied to obtain the potential coefficient of droplets interaction and to understand the rules of emulsion formation under controlled conditions. The results are applied to describe the droplet size evolution of other experiments wherein the flow rate of first vapor is interrupted until is obtain certain average radius of droplets, then the flow rate of the other vapor is maintained until the structure and a large arrangement is obtained. Our results and observations may lead to design structured emulsions.

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