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MECHANISM OF GENERATION OF DROPLETS IN A T-JUNCTION FOR LOW CAPILLARY NUMBERS

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Microfluidic devices offer very precise control over size and content of small droplets. The simplest geometry producing droplets - a T-juncion - comprises two perpendicular channels forming the "T" shape. The flow of the dispersed phase, flowing through a side channel, obstructs the flow of a continuous phase in the main channel. The interactions between two immiscible phases inside confined space of a junction lead to the deformation of the interface and generation of droplets.

Although the mechanism of generation of droplets in microfluidic devices, especially in the T-junction, has been thoroughly studied in number of publications [1-3], there are still gaps in our understanding of this process.

Hereby we present our studies on the formation of droplets for very low Capillary number ($Ca < 10^{-3}$). We observed that the droplet's size rises up for capillary number decreasing below certain critical value. These observations have not been predicted by the current models describing generation of droplets. We will present that this phenomenon can be explained taking into account the fact, that a droplet doesn't fill the whole rectangular cross-section of the channel, allowing for the flow of the continuous phase through the corners. For the low capillary number the continuous phase can leak through corner gutters and bypass a tip of droplet phase. Capillary force prevents the detachment of the droplet until the length of the gutter (and its hydrodynamic resistance) reaches certain critical value above that, the leakage becomes insufficient to prevent deformation of the interface. In this way the process of "pumping" a droplet is extended resulting in a larger droplet.

We will present our observations of the formation of droplets for different width of channels (from 200μm to 800μm) of T-junctions milled in polycarbonate. Image processing of the retrieved data allows for quantitative characterisation of whole process and explanation of the mechanisms governing generation of droplets.

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