

# Nanoemulsion stability and degradation

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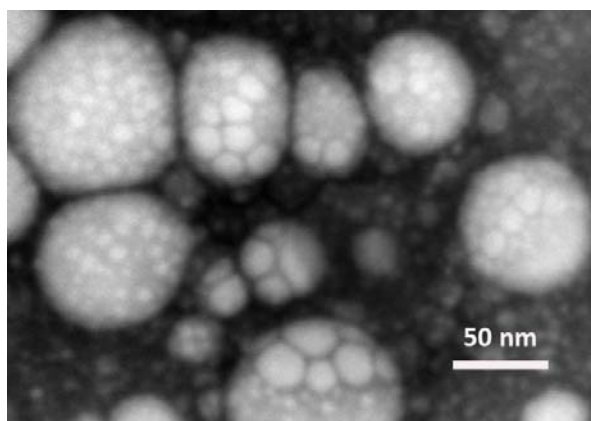
Following a literature survey, a governing mechanism of O/W nanoemulsion degradation is Ostwald ripening. In most cases, the contribution of coalescence, flocculation, and creaming was not found to have any significant effect on nanoemulsion breakdown. Nevertheless the reported experimental rates of Ostwald ripening are usually higher than the theoretical values and are in the range of  $10^{-29}$ - $10^{-27}$  m<sup>3</sup>/s.

In this investigation we studied O/W nanoemulsion stabilized by nonionic surfactants and with mineral oil as dispersed phase. The results indicate that the rate of Ostwald ripening for quasi-steady-state conditions does not vary with increasing oil concentrations in nanoemulsions up to 0.05. The rates of Ostwald ripening is equal to  $(1.5 \pm 0.3) \cdot 10^{-29}$  m<sup>3</sup>/s in nanoemulsion stabilized by Brij 30 and  $(1.1 \pm 0.3) \cdot 10^{-29}$  m<sup>3</sup>/s in nanoemulsions stabilized by Tween 80 and Span 80 mixture. The main mechanism of diluted O/W nanoemulsion destabilization is Ostwald ripening.

In more concentrated nanoemulsions with oil fraction of up to 0.45 coarsening occurs via different mechanisms. The growth rate of droplets, i.e. the change in the cube of the mean radius with time, increases from  $10^{-29}$  to  $10^{-27}$  m<sup>3</sup>/s with increasing oil concentration in nanoemulsions. During the first days the contribution of flocculation prevails over other processes in nanoemulsions stabilized by Brij 30. Coalescence is the main mechanics of degradation of these nanoemulsions for long time.

The droplet growth due to Ostwald ripening takes place during 5-10 days after nanoemulsion preparation in the case of stabilization by Tween 80 and Span 80. Flocculation has a substantial impact on the stability behavior of these nanoemulsions on later stages.

Using Tween 60 and Span 60 as surfactants leads to the formation of the solid-like adsorption layer on the surface of oil droplets and as a result to strong retardation of Ostwald ripening at ambient temperature. The investigations of mixed monolayers in nanoemulsions show that the structure of the solid adsorption layer is discrete and consists of domains with different melting point in the range from 25 to 50 °C.



**Figure 1** The microphotograph of droplets in O/W nanoemulsion stabilized by Tween 60 and Span 60 mixture

Nanocapsules generated from these nanoemulsion droplets demonstrate long-term colloidal stability and are suitable for use as drug carriers.

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