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Gel-like double-emulsion droplets[1] JAN GUZOWSKI, Princeton University, PIOTR KORCZYK, PIOTR GARSTECKI, Polish Academy of Sciences, HOWARD STONE, Princeton University — We experimentally study the problem of packing of micro-droplets inside a droplet of another immiscible liquid phase. We use microfluidics to encapsulate multiple monodisperse aqueous segments inside a drop of oil. For small numbers N (N<10) of the aqueous droplets and at their volume fraction in oil exceeding the close-packing threshold we observe multiple metastable structures with well-defined point-group symmetries. We attribute the observed metastability to the deformability of the droplets which leads to effective many-body interactions and energy barriers for rearrangement. By changing the composition of the oil phase we find that when the surface tensions of the droplets and of the encapsulating phase are comparable, the energy barriers are high enough to trap elongated structures or even linear chains, independently of N. However, when the surface tension of the encapsulating phase is much larger than that of the droplets, non-spherical morphologies are stable only at sufficiently high N. In such a case multiple internal interfaces can hold stresses and prevent relaxation of the global deformations which leads to a plastic, gel-like behavior. Our findings can serve as guidelines for synthesis of functional particles as well as for designing biomimetic materials, e.g. for tissue engineering.

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