

Supporting Information

Formation of Polymer Microrods in Shear Flow by Emulsification - Solvent Attrition Mechanism

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Formation of SU-8 rods by hand shaking or by a magnetic stirrer

Fiber-like and rod-like SU-8 particles could also be formed by simple hand shaking of the polymer solution inside viscous media or by stirring it with a magnetic stirrer. The quality of the SU-8 rods formed in these ways was worse since it was not possible to avoid the appearance of turbulences and to assure conditions of uniform homogeneous shear in all parts of the vessel. The length of the rods formed and the polydispersity in their sizes were largest for the hand-shaken samples and smallest for the homogenized ones. This is in agreement with the conclusions for the effect of shear stress on the process in the manuscript. Typical pictures of SU-8 rods formed by hand shaking, stirring with a magnetic stirrer and by a homogenizer are presented in Figure 1.

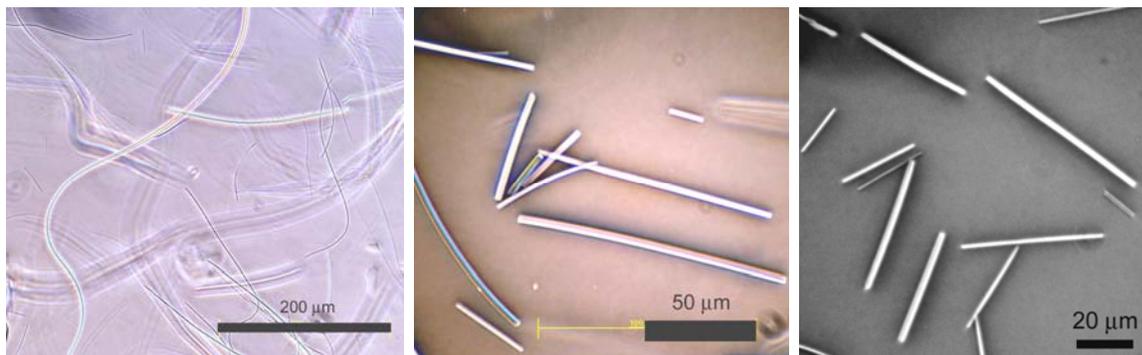


Figure 1. Optical micrographs of rod-like SU-8 particles formed in a shear flow created by (a) hand shaking, (b) magnetic stirrer, and (c) a homogenizer. The dispersion medium in all cases is Glycerin/Ethylene Glycol 1:1 volume ratio.

Preparation of SU-8 rods by shearing in concentric cylinder rheometer

We prepared a few batches of microrods by shearing inside an Advanced Rheometer (AR200) with two concentric cylinders with 500 μm gap between them. Dimensions and polydispersity of the SU-8 rods prepared with the rheometer were slightly smaller than the ones of the rods prepared by the homogenizer (though the two sets of data are not directly comparable due to the difference in the residence time of the polymer solution before shearing, which was much higher for the rheometer). Despite the significantly higher shear stress achieved in the rheometer, the rods were not as short as expected because of the competing process of the polymer solidification (see discussion in manuscript).

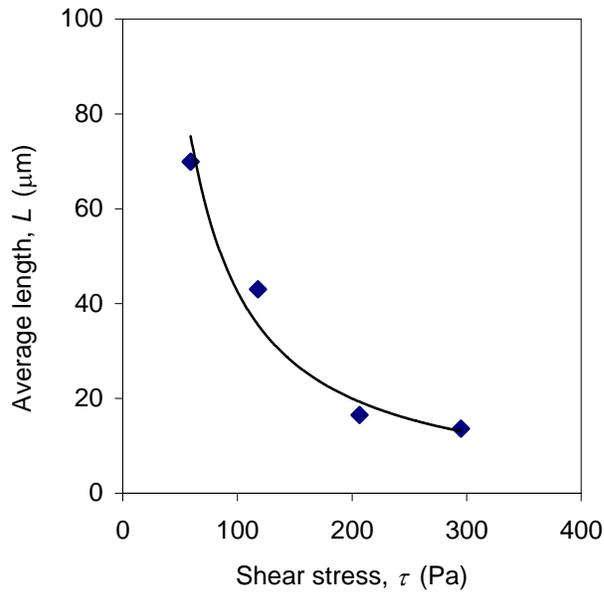


Figure 2. Average length of SU-8 rods, L , formed by shearing inside a rheometer with concentric cylinders. The dispersion medium is a 1/1 mixture of Glycerin/Ethylene Glycol.

Summary of the tests of liquid mixtures as media for preparation of SU-8 microrods

SU-8 microrods can be prepared in any medium that satisfies the conditions discussed in the main body of the paper:

- SU-8 is not soluble in neither of the medium components
- High enough and uniform viscous shear stress
- Attrition of the initial SU-8 solvent (GBL) to the media occurs at an optimal speed

The results of tests of various liquid mixtures as media for preparing polymer microrods in conditions of viscous shear are listed in Table 1. Rods form in media satisfying above requirements; irregular particles or droplets form in media where one or more of the requirements are not met.

Table 1. Summary of all media tested and the results of the process.

Dispersion Medium	Result	Comments
Glycerin	Microrod formation	The necessary conditions for viscous shearing and solvent attrition have to be met
Glycerin/Ethylene Glycol	Microrod formation	
Glycerin/Ethanol	Microrod formation	
Glycerin/Isopropanol	Microrod formation (Figure 3)	
Glycerin/Methanol	Microrod formation	
Water/PVA	Microrod formation (Figure 4)	The PVA concentration has to be high enough to increase the medium viscosity to values comparable to ones of glycerin and its mixtures
Ethylene Glycol	Irregularly shaped particles and fibers (Figure 5)	Fast attrition and low viscous stress
Ethanol	Irregularly shaped particles and fibers	Fast attrition and low viscous stress
Glycerin/Acetone	Oil drops	Acetone is a good solvent for SU-8. It decreases the rate of attrition and may completely prevent the solidification at high enough concentrations
Glycerin saturated with GBL	Oil drops	There is no solvent attrition leading to microrod formation

Examples of the particles formed in some of these systems are presented in Figures 3-5.

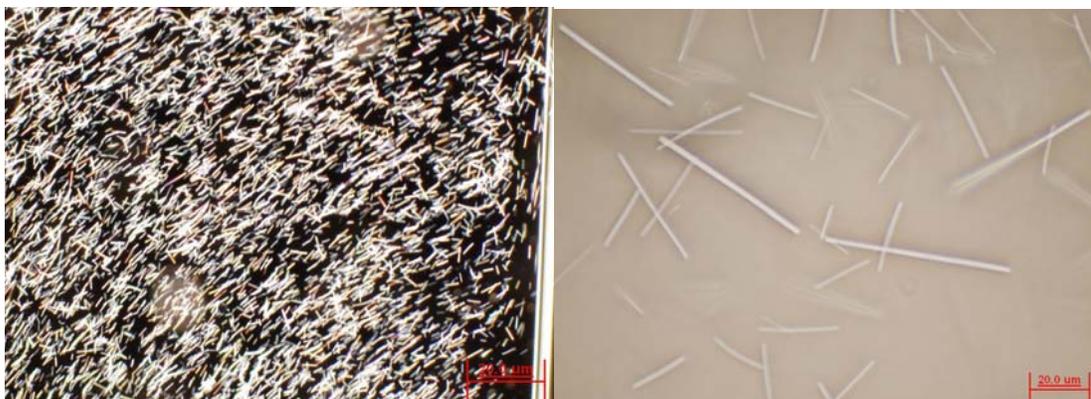


Figure 3. Images of SU-8 rods formed in Glycerin/Isopropanol mixture (75/25 v/v).



Figure 4. Images of SU-8 rods formed in water containing polyvinyl alcohol (PVA). The concentration of PVA allowing rod synthesis has to be in a range in which its water solutions meet the criteria for the viscous ratio and stress. The shear flow is created by a magnetic stirrer.

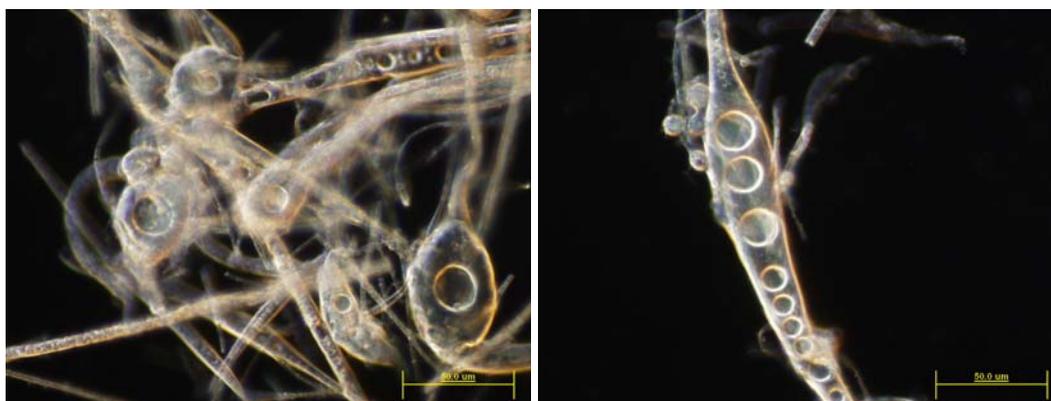


Figure 5. Images of irregular SU-8 particles formed in pure Ethylene glycol.