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Comment on egusphere-2022-1004

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Referee comment on "New ring shear deformation apparatus for three-dimensional multiphase experiments: first results" by Shae McLafferty et al., EGUsphere, https://doi.org/10.5194/egusphere-2022-1004-RC1, 2022

Summary

The manuscript presents a novel ring shear tester with a transparent side wall to monitor deformation during shear. The machine is able to resolve the interaction of viscous and brittle phases by direct observation. Therefore, the machine has a high potential to improve the understanding of deformation in analogue experiments and can be used to improve the benchmarking of numerical models with experimental observations. The apparatus allows for several configurations that are desirable, such as constant force or constant rate boundary conditions as well as constant volume and constant normal stress experiments. This makes the approach very versatile and suitable to measure under many different conditions. An attachable spring allows for swift modification of the apparatus stiffness to modify the loading conditions such that stick-slip can be enforced or suppressed which is useful for measuring rate-and-state properties or similarly run stick-slip experiments.

The experimental setup and monitoring of the deformation is described clearly and would allow to rebuilt a similar machine in other laboratories. The qualitative description (section 5.1) of the deformation in the sample is good and clearly highlights the big advantage of this setup. However, I identify several problems with the presented experimental results which I outline as separate sections below.

Calibration of Device

The authors show results from experiments on HydroOrbs, HydroCubes, Carbopol, water and mixtures thereof. Table 2 shows the material properties but it is unclear whether these have been measured in this new device or in a separate apparatus. A newly developed measuring instrument should be calibrated on standardized materials so that the inaccuracies occurring with the measurement geometry can be clearly quantified. This could encompass a comparison of material properties from literature (e.g. Carbopol) with the parameters measured by the presented machine. Alternatively, other materials with well defined properties could be measured in this and another machine. Otherwise, a falsifying influence of the measurement geometry or design of the apparatus cannot be excluded. Therefore, I suggest that a quantitative comparison of at least one material is added to this manuscript to demonstrate that what the machine actually measures is valid. For example this could include a rheometric test of Carbopol or any other fluid (e.g. a silicone oil) without a spring at multiple loading rates (CSR-Test) to recover apparent viscosities.

Noisyness of Signal and Data

The authors show the result of a background experiment with several possible sources of experimental noise and how each type of noise is treated. Fluctuations on a scale of 5 to 20 N are common over the whole experimental run. Additionally, there are several small scale noise components, such as the ones coming from the stepper motor. To me it is unclear what is signal and what is noise. For similar experiments done by the authors and coauthors the magnitude of stick-slip observations was in the order of 0.1 to 1 N. I would expect a similar range which would be undistinguishable from the extremly noisy signal coming from the machine. However, the measurement geometry was different for these experiments (Birren and Reber 2018), so what would be the expected magnitude of signal in the shear tester presented here? Additionally, how accurate is the load cell used here? From the manufacturers website I could see that most accuracy quantities (non-linearity, hysteresis, repeatability and offset) are in the range of .1 to 1 % of the rated output, which would fall into the region of the quantity that the authors would try to measure. Therefore, I am not sure whether the signal to noise ratio is actually high enough to discern between the signal (stick-slip) and external influences. This also leads to my last point:

Processing of Experimental Results

It is not clear to me what signal the authors are trying to extract from the data set. The filtering and noise processing applied is questionable. Am I correct that the final 'signal' is shown in Figure 6 c? To me this looks like pure noise, especially when considering the accuracy of the sensor. A better way to filter the signal in my view would be first to analyze the input time series with a frequency based method (FFT or continuous wavelet transformation) to see the magnitude and frequency of various noise components in the signal. Then a frequency based filter (High-Pass-Low-Pass etc...) could be designed to filter out specific frequencies from the signal improving the remaining signal. Contributions from the stepper motor and power grid frequency in the signal are then easily rooted out and removed from the signal. I understand from the manuscript that the variance is used as a simple proxy to how strongly the force fluctuates in the experiment and that the authors are able to recover a transient change in fluctuations over several rotations which could be related to the formation of a through going shear zone in the material. However, I am not sure whether this is an actual signal or just a processing artifact.

Concluding Remarks

As such the manuscript provides a valuable asset to the analogue modelling community but several methodological improvements are required. Other than the above issues I have no major comments. A minor issue is that the style of the bibliography entries is not consistent and some are missing a DOI. The language is very good and I could not find any spelling or grammar issues.

Therefore, I suggest major revisions because additional measurements are needed and a different data processing should be applied.