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The chemical stability and cytotoxicity of carbonyl iron particles grafted with poly(glycidyl methacrylate) and the magnetorheological activity of their suspensions

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Supporting information

The reaction of iron in aqueous solution of hydrochloric acid proceeds [1] according to the following equation:

$$Fe + 2HCl + 6H_2O \rightarrow [Fe(H_2O)_6]Cl_2 + H_2$$
 (1)

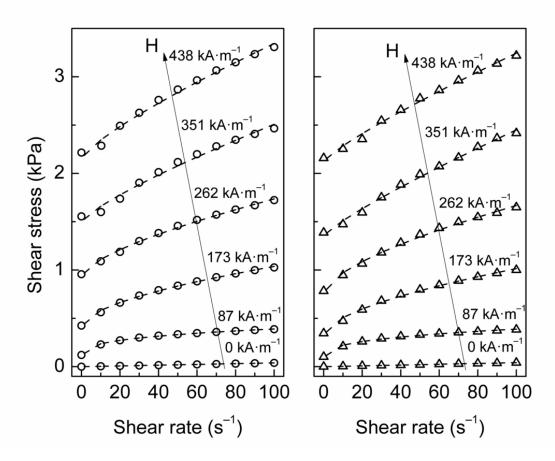


Figure S1. Rheograms of the MR suspensions containing 40 wt.% of CI-PGMA-1 particles (*open circles*), and CI-PGMA-2 particles (*open triangles*) showing experimental data fitted with the HB model (*dashed lines*) under various magnetic field strengths.

Non-linear regression was performed on Origin[®] (© OriginLab Corporation) curve fitting package in order to determine τ_0 , K, n parameters of Herschel-Bulkley (HB) model. The accuracy of HB predictions was assessed with three statistical indicators. Validity of correlation coefficient (R_C^2), to evaluate the fit of non-linear models has been questioned [2–4], therefore the sum of square errors (SSE), and the root mean square error (RMSE) are also reported. These parameters are defined according to equations:

$$SSE = \sum_{i}^{N} (\tau_i - \tau_p)^2 \tag{2}$$

where τ_i and τ_p are observed and predicted shear stresses, and

$$RMSE = \sqrt{\frac{SSE}{N - p}} \tag{3}$$

where N is the number of measurements, and p denotes the number of parameters of the model. For further references see Kelessidis *et al.* [4].

Table S1. Statistical evaluation of the HB model predictions

Magnetic	0 kA·m ⁻¹	87 kA⋅m ⁻¹	173 kA·m ⁻¹	262 kA·m ⁻¹	351 kA·m ⁻¹	438 kA·m ⁻¹
field						
1		MR suspe	ension of bare C	I particles	l	
$ au_0$ [kPa]	1.26e-05	0.120	0.519	1.215	2.046	2.941
K [kPa·s ⁿ]	4.59e-04	0.115	0.143	0.091	0.039	0.035
n [-]	0.929	0.258	0.395	0.557	0.761	0.782
R_C^2	0.999	0.991	0.990	0.998	0.997	0.997
SSE [kPa ²]	5.04e-07	0.003	0.013	0.004	0.011	0.012
RMSE [kPa]	2.51e-04	0.020	0.041	0.013	0.037	0.039
1		1			l	·
		MR suspens	sion of CI-PGM	A-1 particles		
τ_0 [kPa]	1.26e-05	0.107	0.417	0.944	1.503	2.160
K [kPa·s ⁿ]	4.36e-04	0.061	0.044	0.035	0.024	0.029
n [-]	0.973	0.333	0.571	0.675	0.804	0.802
R_C^2	0.999	0.999	0.999	0.998	0.991	0.991
SSE [kPa ²]	3.35e-08	1.45e-04	0.0007	0.002	0.020	0.025
RMSE [kPa]	6.48e–05	0.004	0.009	0.016	0.049	0.056
		1	1	•	•	•
		MR suspens	sion of CI-PGM	A-2 particles		
τ ₀ [kPa]	1.26e-05	0.089	0.332	0.768	1.359	2.130
K [kPa·s ⁿ]	4.63e-04	0.060	0.045	0.046	0.021	0.021
n [-]	0.971	0.347	0.587	0.642	0.854	0.853
R_C^2	0.999	0.998	0.998	0.998	0.997	0.997
SSE [kPa ²]	5.81e-08	3.36e-04	0.002	0.003	0.007	0.008
RMSE [kPa]	8.52e-05	0.007	0.017	0.020	0.029	0.032

Computed parameters confirmed almost Newtonian behavior of all magnetorheological (MR) suspensions in the off-state, thus behavior with almost zero yield stress and non-Newtonian index close to 1. However, after the application of an external magnetic field, yield stress appeared and pseudoplasticity occurred, as supported by corresponding parameters. High values of R_C^2 for all data samples, and generally low values of SSE and RMSE in majority of the cases (Table S1) indicate that the experimental data are in a very good agreement with HB model predictions. To conclude, considering these results, the HB model appeared to be a reliable analysis tool for flow curve fitting of prepared MR suspensions.

References

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