Behavior analysis of two-component waterproofing mortars by mechanical and NMR investigations

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Abstract

Advanced ^{1}H NMR relaxometry becomes more and more important tool used for the characterization of a large range of materials like mortars. CPMG pulse sequence and saturation recovery methods were used for the measurement of four samples (MF, C166, P288, AQSE) of two-component waterproofing mortars at 1, 3, 7, and 28 days after preparation. In general, four dynamics components were observed for the T_2 Laplace distributions except for T_2-distribution measured for MF sample at 1 day after preparation. Their characterization reveals the dynamics and mobility of protons. In general, at low T_2 values these peaks can be associated with bound water. The flexural tensile strength and compressive strength were measured for all samples and the mechanical properties were correlated with NMR parameters. The hydrating behavior of the two-component waterproofing mortar dried under natural conditions was observed and the hydrophobic capabilities

Table 1 Chemical compounds of motrars (wt%) used in the experiments.

No.	Samples	O [%]	Ca [%]	Si [%]	S [%]	Al [%]	K [%]	Mg [%]	Na [%]	Cl [%]	Ti [%]	Fe [%]
		chemical compounds										
1	**AQSE**	59.7	29.8	4.5	1.6	1.5	1.3	0.8	0.7	-	-	-
2	**C166**	57.0	27.3	8.4	1.6	1.9	1.5	0.4	1.7	0.2	-	-
3	**MF**	47.8	33.8	9.1	1.4	2.1	1.5	0.6	0.9	0.2	1	1.7
4	**P288**	47.5	38.3	7.1	2.1	1.9	1.7	0.5	0.7	0.2	-	-

Fig. 1 The optical images of a) C166, b) AQSE, c) MF and d) P288 after preparation.

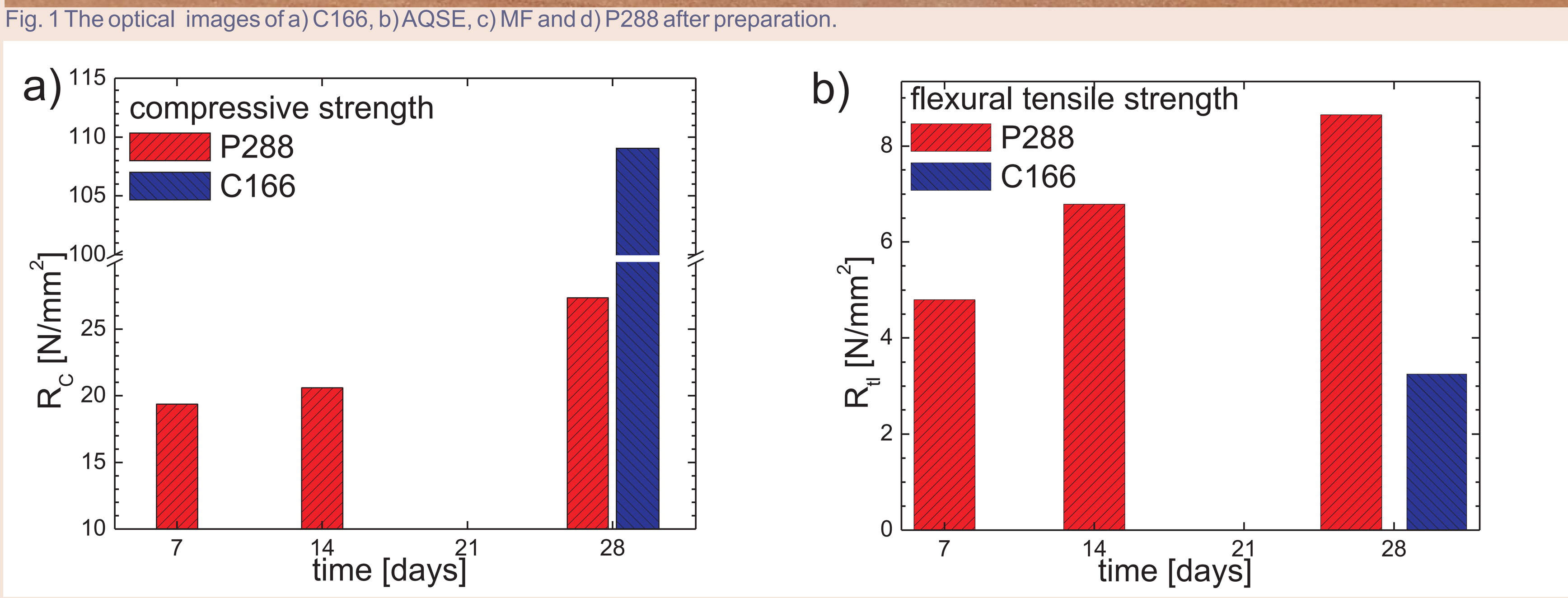

Fig. 2 a) Compressive strength measured for P288 and C166 samples of waterproof 2K mortars at 7, 14 and 28 days after preparation; b) Flexural tensile strength measured for P288 and C166 samples of waterproof 2K mortars at 7, 14 and 28 days after preparation.

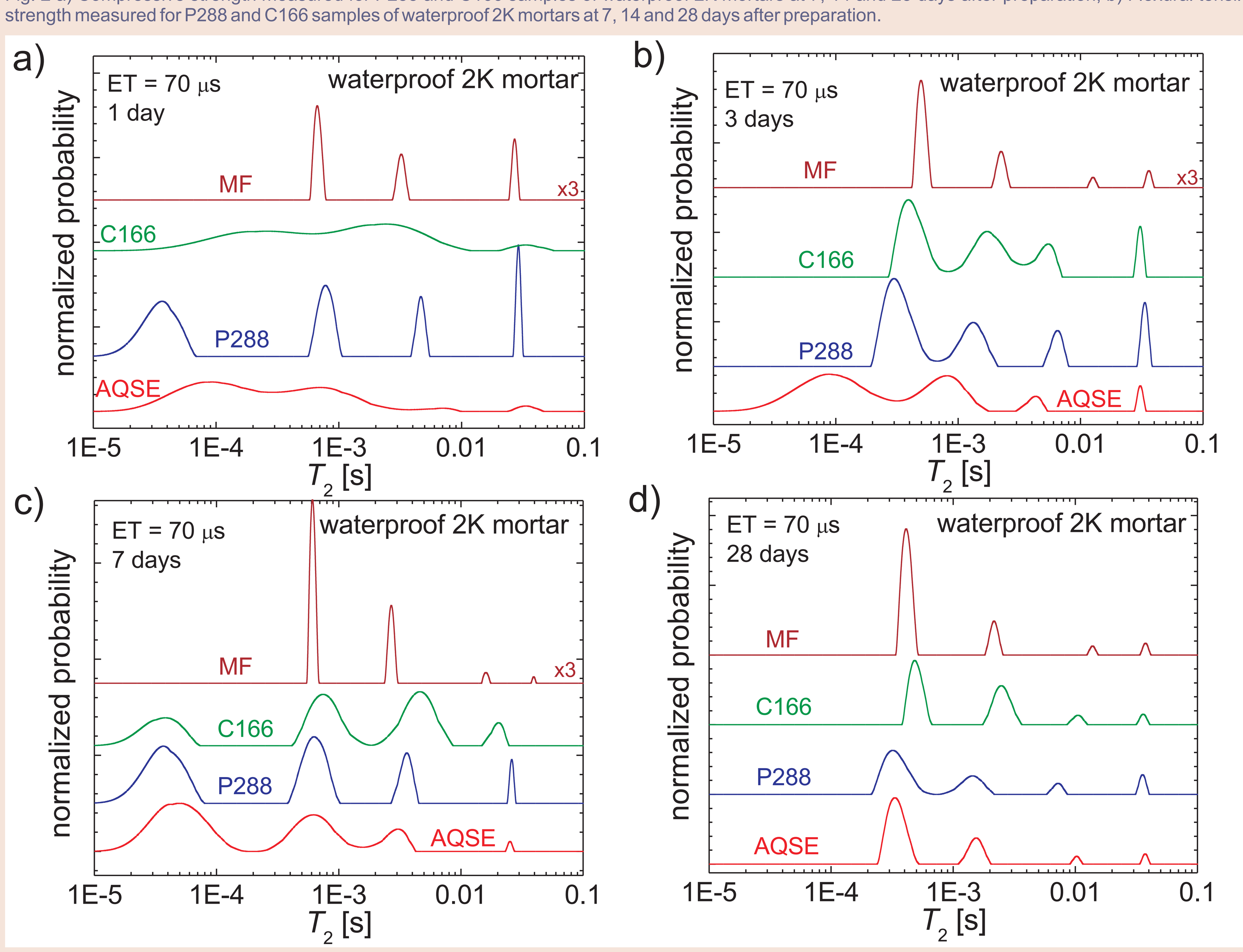

Fig. 3 The distributions of normalized T_2 measured for four different samples at a) 1 day, b) 3 days, c) 7 days and d) 28 days after preparation.

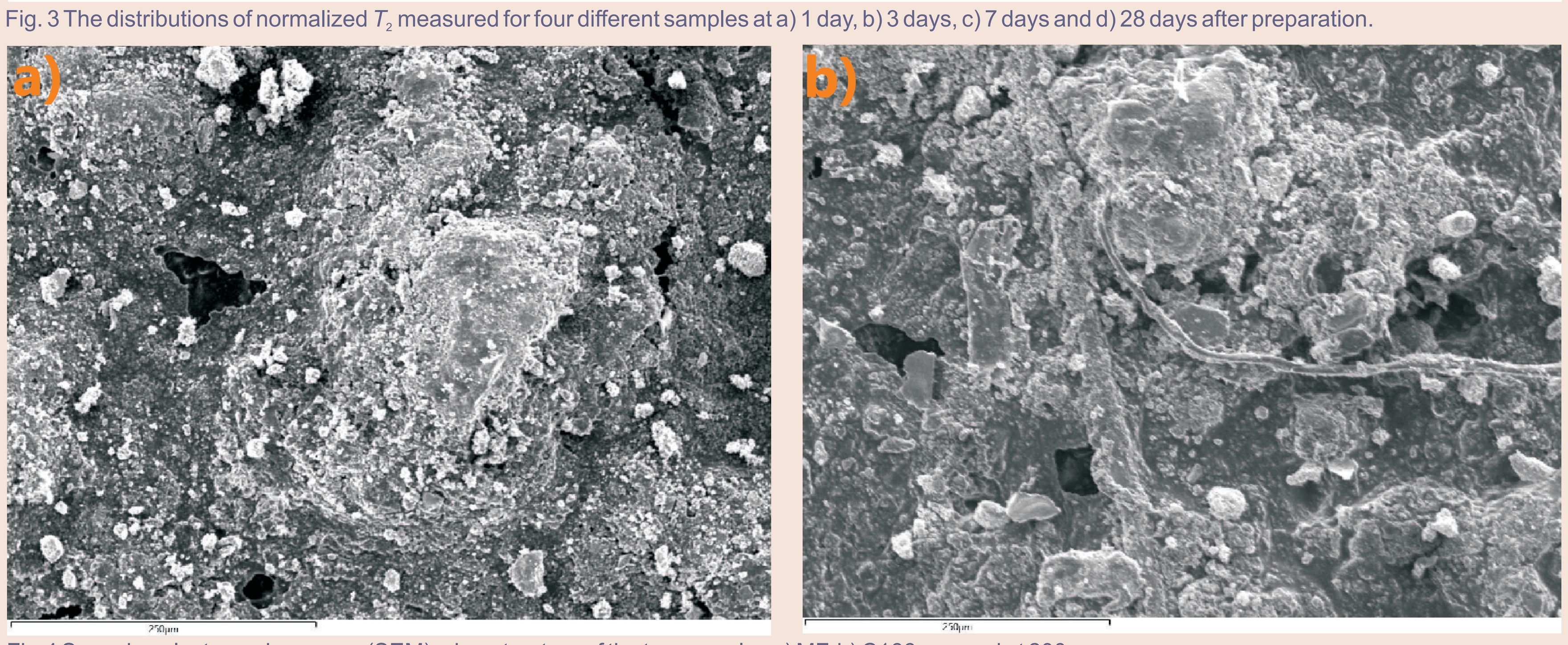

Fig.4 Scanning electron microscopy (SEM) microstructure of the two samples a) MF, b) C166 zoomed at 200x.

Conclusions

- At 1 day after preparation four dynamics components were observed in the T_2 distributions for all samples except MF mortar .
- Significant differences were observed in the NMR measurements of the T_2 distribution between the MF and the rest of the samples due to the Fe and Ti magnetic impurities.
- FT-IR spectroscopy showed that the C166 sample has a significant absorbance in the range of 350 - 1300 cm^{-1} compare to ASQE, MF and P288.
- After hydration, the distributions of T_2 transverse relaxation times showed a change in pore size and homogeneity for all pore types and all mortar samples.
- The T_1-T_2 correlation maps show how the pores are filed by rehydration for the mortar sample with fully formed pores structure (28 or more days from preparation).

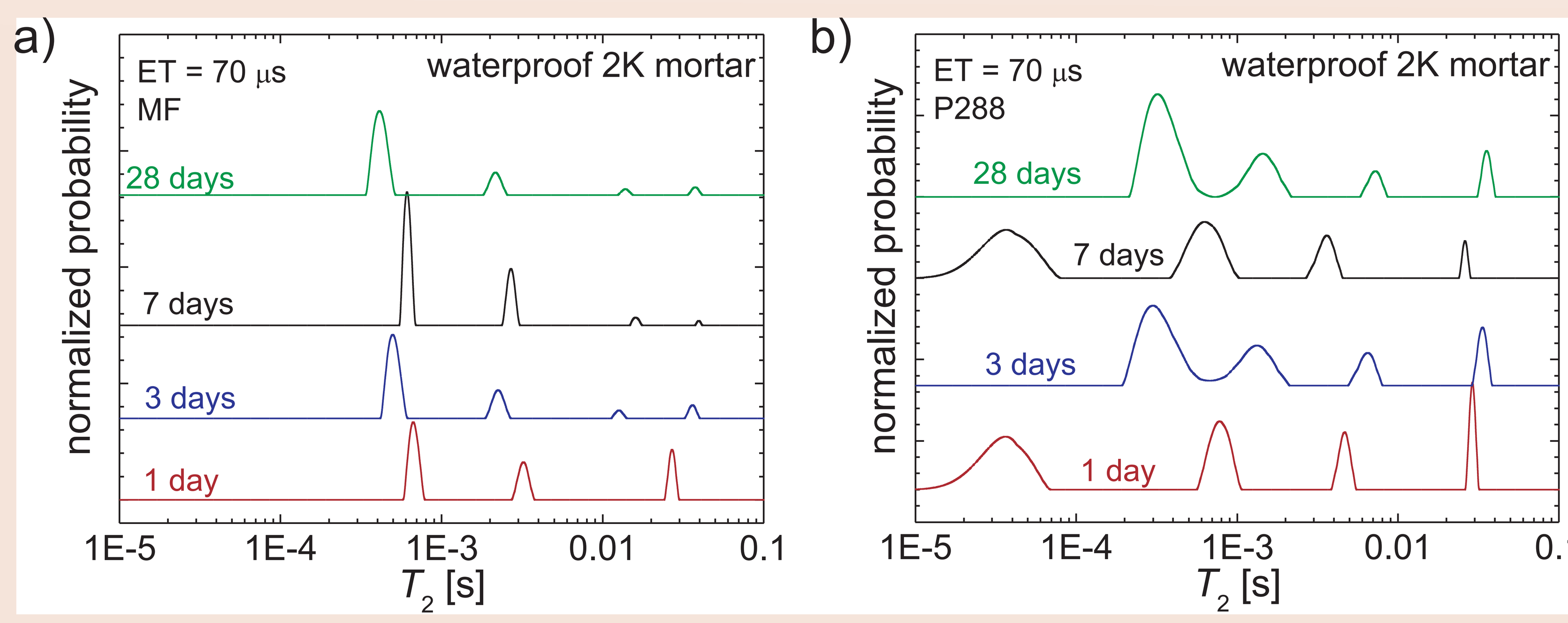

Fig. 5 The distributions of normalized T_2 measured for a) MF, b) P288 samples at 1, 3, 7 and 28 days after preparation.

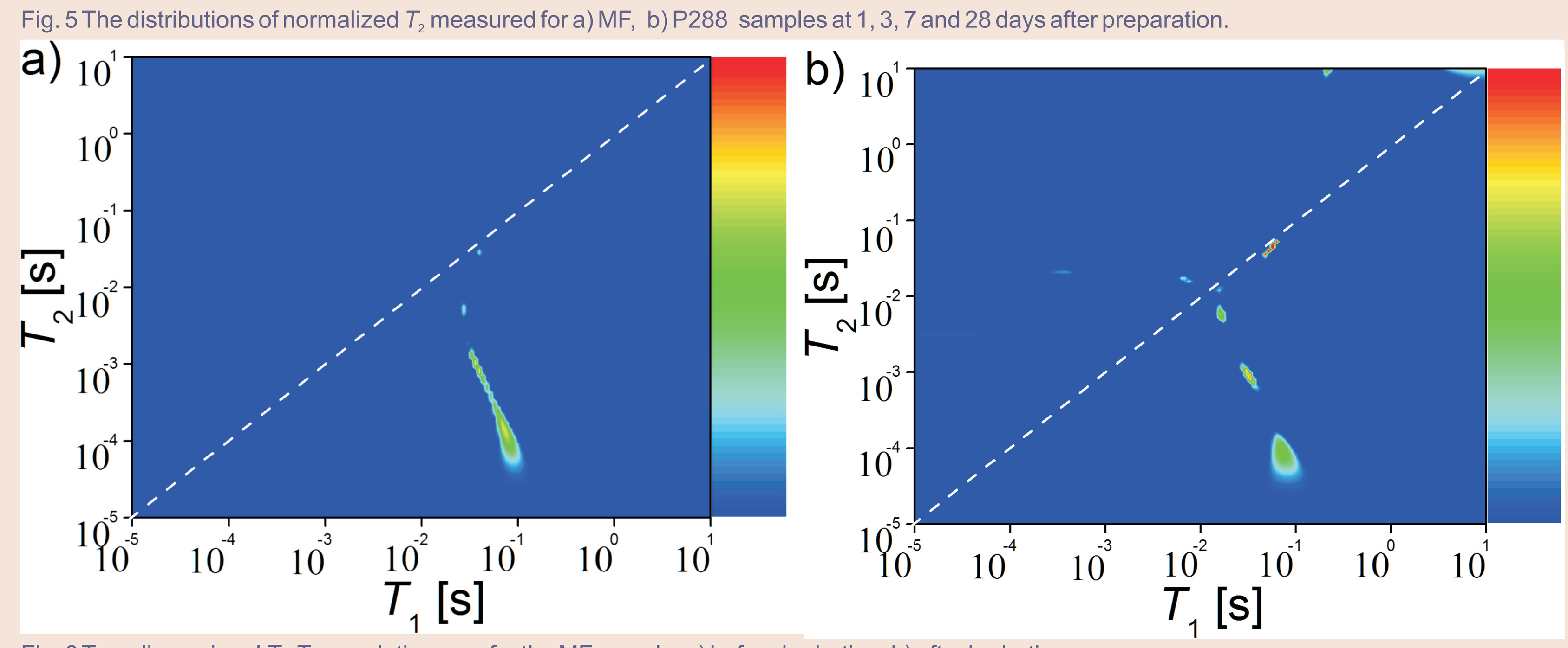

Fig. 6 Two-dimensional T_1-T_2 correlation map for the MF sample: a) before hydration, b) after hydration.

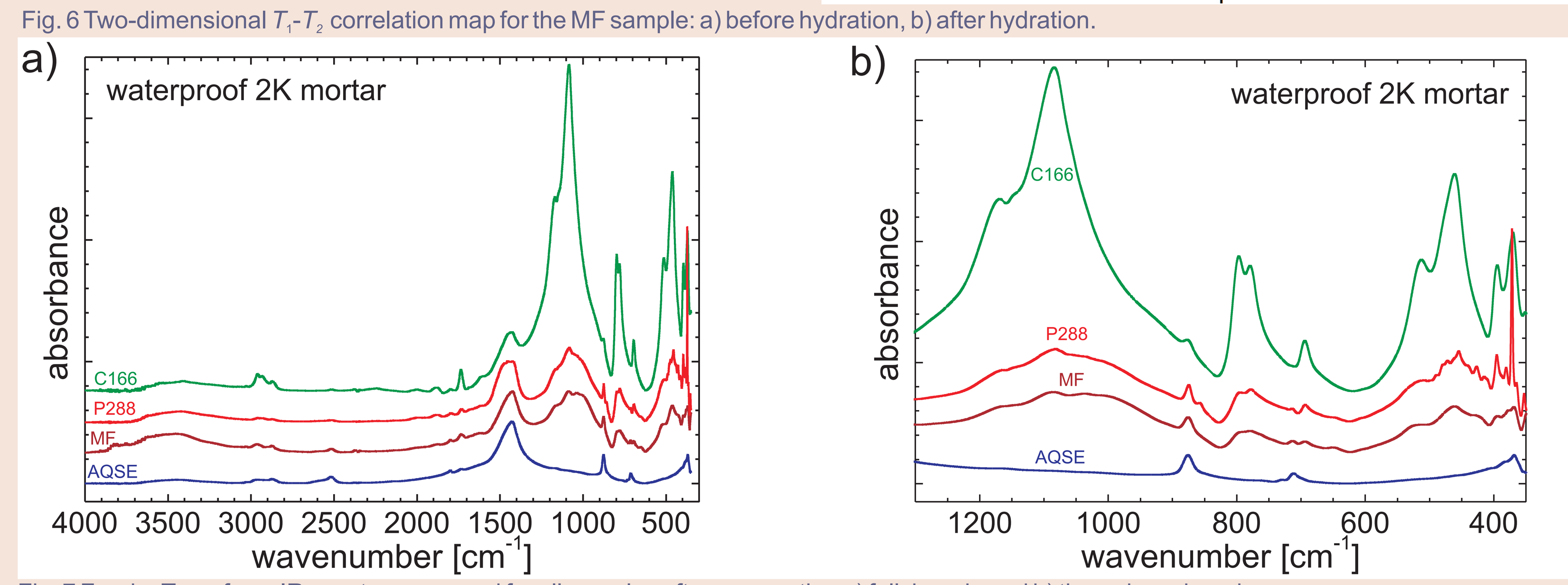

Fig. 7 Fourier Transform-IR spectra measured for all samples after preparation a) full domain and b) the reduce domain.

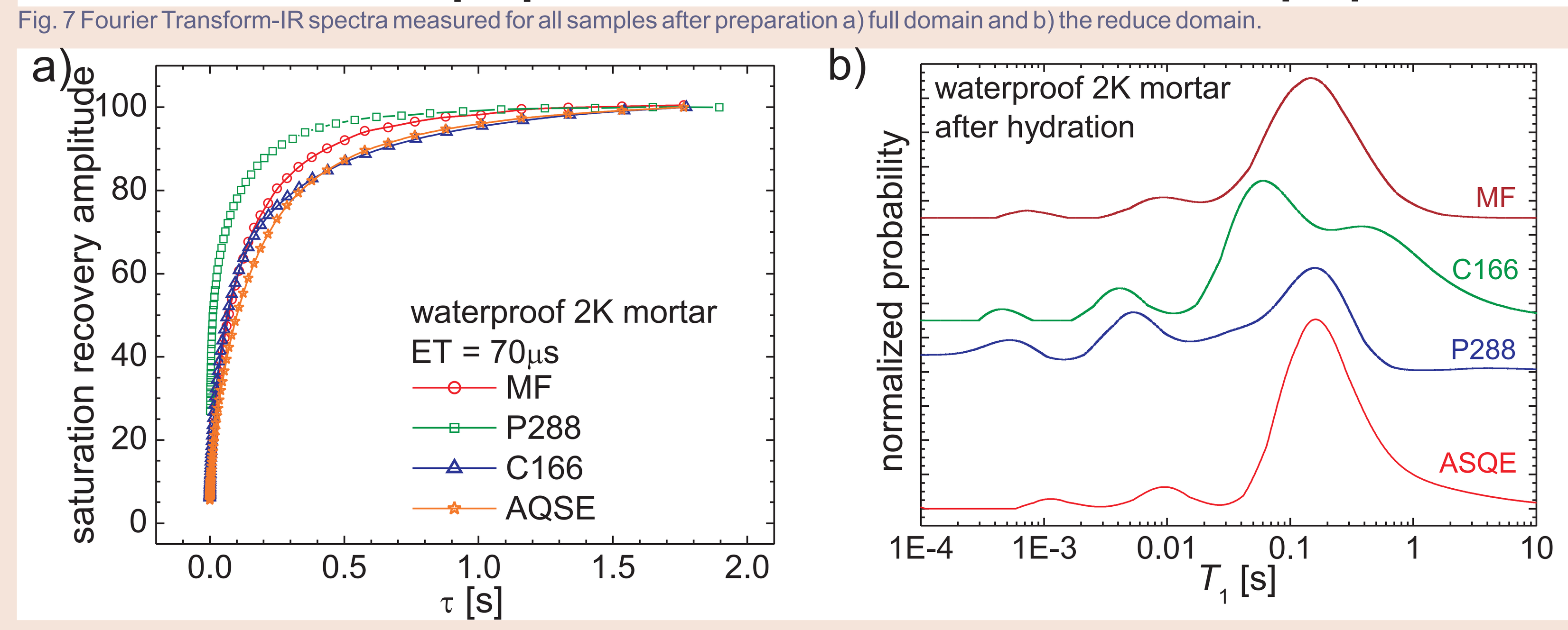

Fig. 8 a) Normalized saturation recovery and b) The distributions of normalized T_1 measured for all samples.

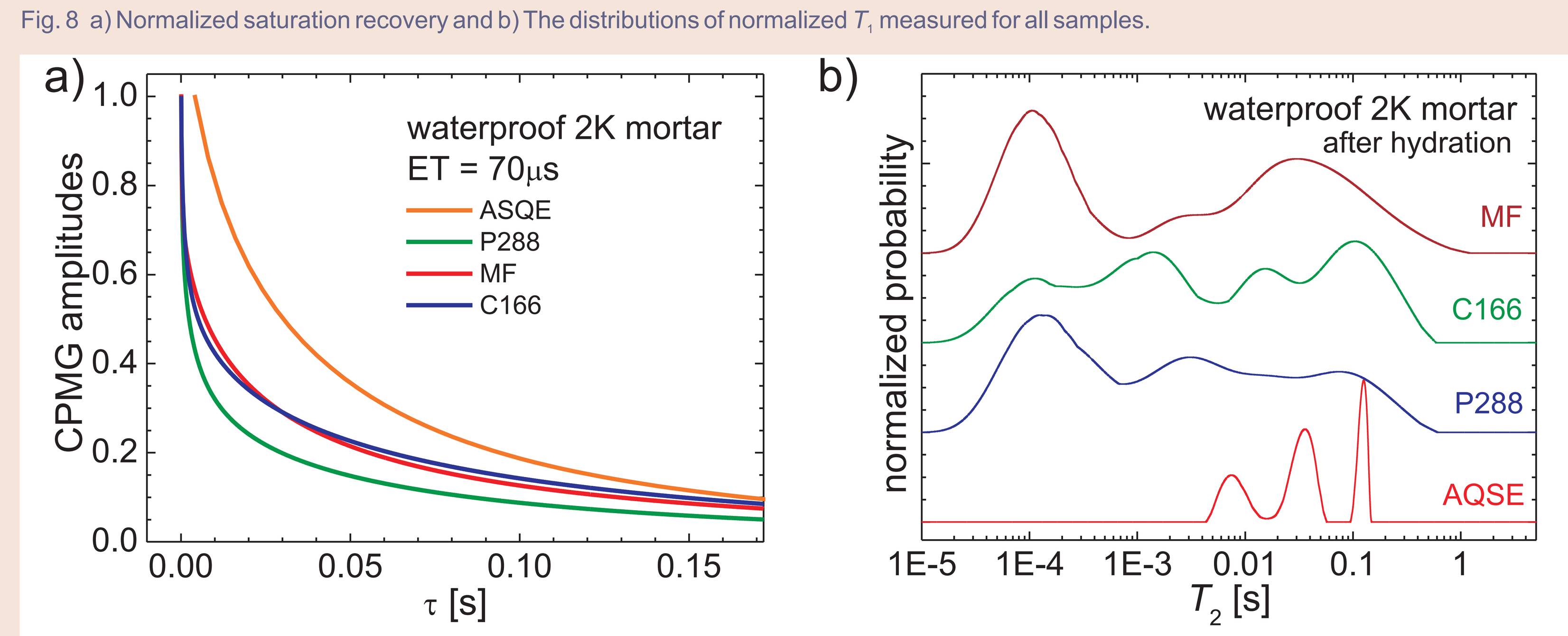

Fig. 9 a) Normalized CPMG decay and b) The distributions of normalized T_2 measured for all samples after hydration.

References

1. Ai Zhag, Wencui Yang, Yong Ge, Yaozeng Wang, Penghuan Liu: *Study on the hydration and moisture transport of white cement containing nanomaterials by using low field nuclear magnetic resonance*,Construction and Nuilding Materials, 249, 118788, 2020.
2. Jumate E., Manea D.L., Moldovan D., Fechete R.: *The Effects of Hydrophobic Redispersibele Powder Polymer in Portland Cement Based Mortars*. Procedia Engineering,181, 316-323, 2017.
3. Jumate E., Moldovan D., Manea D.L., Demco D.E., Fechete R.: *The Effects of Cellulose Ethers and Limestone Fillers in Portland Cement-Based Mortars by ^{1}H NMR relaxometry*. Applied Magnetic Resonance 47(12), 1353-1373, 2017.
4. SR EN 1015-11:2002/A1:2007, *Methods of test for mortar for masonry. Part 11: Determination of flexural and compressive strength of hardened mortar, 2007.*

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