Supporting information

# Tailoring the magnetic and structural properties of Manganese/Zinc doped Iron Oxide Nanoparticles through microwaves-assisted polyol synthesis

## Table S1. Precursors amount

*Table S1.* Amount of the precursors employed for the microwave-polyol assisted synthesis of the magnetic nanoparticles.

| | Sample | Fe ac (mg) | Mn ac (mmol) | Zn ac (mg) | Zn ac (mmol) | Mn ac (mg) | Mn ac (mmol) |
|---|---|---|---|---|---|---|---|
| DEG | **MW10**_MW01 | 300 | 1.72 | - | - | - | - |
| | MW1 | 275 | 1.58 | 27 | 0.15 | - | - |
| | MW2 | 250 | 1.44 | 52.6 | 0.29 | - | - |
| | MW3 | 225 | 1.3 | 78.9 | 0.42 | - | - |
| | MW4 | 200 | 1.16 | 105 | 0.57 | - | - |
| | MW5 | 252 | 1.49 | 42 | 0.23 | - | - |
| | MW6 | 233 | 1.38 | 42 | 0.23 | 19 | 0.11 |
| | MW7 | 215 | 1.27 | 42 | 0.23 | 38 | 0.22 |
| | MW8 | 196 | 1.16 | 42 | 0.23 | 57 | 0.33 |
| | MW9 | 178 | 1.05 | 42 | 0.23 | 76 | 0.44 |
| TEG | MW10 | 251.2 | 1.45 | 42 | 0.23 | - | - |
| | **MW15**_MW11 | 300 | 1.72 | - | - | - | - |
| | **MW15Z**_MW12 | 275 | 1.58 | 27 | 0.15 | - | - |
| | MW13 | 250 | 1.44 | 52.6 | 0.29 | - | - |
| | MW14 | 240 | 1.38 | 42 | 0.23 | 19 | 0.21 |
| | MW15 | 221 | 1.27 | 42 | 0.23 | 38 | 0.22 |
| | MW16 | 202 | 1.16 | 42 | 0.23 | 57 | 0.33 |
| | MW18 | 266 | 1.53 | 27 | 0.15 | 9 | 0.05 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | MW19 | 258 | 1.48 | 27 | 0.15 | 18 | 0.1 |
| | **MW10ZM**_MW20 | 249 | 1.43 | 27 | 0.15 | 27 | 0.15 |
| | MW21 | 255.7 | 1.47 | 27 | 0.15 | 19 | 0.11 |
| | MW22 | 236.5 | 1.36 | 27 | 0.15 | 38 | 0.22 |
| | MW23 | 217.4 | 1.25 | 27 | 0.15 | 57.1 | 0.33 |

## Table S2. Samples specifications

Here are reported the fundamental characteristics of the synthesized samples: **(i)** the elemental composition obtained from the ICP-OES analysis; **(ii)** the structural characteristics as the (311) peak position, the lattice constant and the crystal size, resulting from the XRD path studied with Bragg's law and Scherrer equation; **(iii)** the dimensions measured from the TEM pictures; **(iv)** the saturation magnetization values evaluated from the hysteresis loops acquired by the VSM, and corrected by the TGA analysis results.

*Table S2.* Morpho-structural and magnetic characteristics of the synthesized samples.

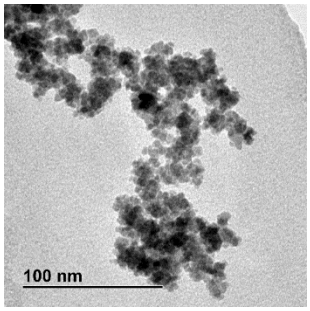
| Sample | Composition | (311) Peak position (°) | Lattice constant (Å) | Crystal size (nm) | TEM size (nm) | Ms (emu/g) |
|---|---|---|---|---|---|---|
| | | **DEG** | | | | |
| **MW10_MW01** | γ-$Fe_2O_3$ | 35.656 | 8,345 | 9.3 | 7.8 ± 0.8 | 69.3 |
| **MW1** | γ-$Zn_{0.2}Fe_{1.8}O_3$ | 35.543 | 8,370 | 6.7 | 4.6 ± 1.3 | 65.9 |
| **MW5** | γ-$Zn_{0.4}Fe_{1.6}O_3$ | 35.465 | 8,388 | 9.3 | 6.3 ± 2.3 | 62.7 |
| **MW2** | γ-$Zn_{0.5}Fe_{1.5}O_3$ | 35.429 | 8,396 | 9.4 | 7.8 ± 2.5 | 64.7 |
| **MW3** | γ-$Zn_{0.8}Fe_{1.2}O_3$ | 35.420 | 8,398 | 9.4 | 7.8 ± 1.7 | 36.0 |
| **MW4** | γ-$ZnFe_1O_3$ | 35.400 | 8,403 | 8.5 | 6.6 ± 1.7 | 8.2 |
| **MW6** | γ-$Zn_{0.45}Mn_{0.15}Fe_{1.4}O_3$ | 35.443 | 8,393 | 9.9 | 7.3 ± 2.8 | 64.7 |
| **MW7** | γ-$Zn_{0.5}Mn_{0.3}Fe_{1.2}O_3$ | 35.374 | 8,409 | 8.3 | 6.0 ± 1.4 | 59.4 |
| **MW8** | γ-$Zn_{0.5}Mn_{0.4}Fe_{1.1}O_3$ | 35.331 | 8,419 | 6.8 | 5.3 ± 1.5 | 49.7 |
| **MW9** | γ-$Zn_{0.55}Mn_{0.65}Fe_{0.8}O_3$ | 35.355 | 8,413 | 5.4 | 6.8 ± 1.7 | 40.6 |
| | | **TEG** | | | | |
| **MW15_MW11** | γ-$Fe_2O_3$ | 35.674 | 8,341 | 15.8 | 15.5 ± 3.6 | 82.9 |
| **MW15Z_MW12** | γ-$Zn_{0.3}Fe_{1.7}O_3$ | 35.599 | 8,358 | 14.6 | 13.4 ± 3.4 | 97.2 |
| **MW10** | γ-$Zn_{0.5}Fe_{1.5}O_3$ | 35.452 | 8,391 | 11.2 | 9.8 ± 2.2 | 86.1 |
| **MW13** | γ-$Zn_{0.6}Fe_{1.5}O_3$ | 35.323 | 8,421 | 14.4 | 12.6 ± 2.8 | 82.9 |
| **MW14** | γ-$Zn_{0.5}Mn_{0.3}Fe_{1.2}O_3$ | 35.414 | 8,400 | 12.2 | 12.6 ± 2.4 | 84.8 |
| **MW15** | γ-$Zn_{0.5}Mn_{0.5}Fe_1O_3$ | 35.437 | 8,395 | 10.9 | 10.6 ± 2.1 | 77.6 |
| **MW16** | γ-$Zn_{0.5}Mn_{0.7}Fe_{0.8}O_3$ | 35.326 | 8,420 | 9.6 | 7.9 ± 2.2 | 46.7 |
| **MW18** | γ-$Zn_{0.24}Mn_{0.10}Fe_{1.65}O_3$ | 35.487 | 8,383 | 11.7 | 10.1 ± 2.8 | 94.6 |
| **MW19** | γ-$Zn_{0.25}Mn_{0.15}Fe_{1.6}O_3$ | 35.512 | 8,377 | 10.9 | 9.2 ± 1.9 | 94.0 |
| **MW10Z_MW20** | γ-$Zn_{0.26}Mn_{0.23}Fe_{1.5}O_3$ | 35.483 | 8,384 | 9.6 | 7.7 ± 1.9 | 91.5 |
| **MW21** | γ-$Zn_{0.28}Mn_{0.08}Fe_{1.64}O_3$ | 35.355 | 8,413 | 11.0 | 9.2 ± 2.2 | 96.9 |
| **MW22** | γ-$Zn_{0.29}Mn_{0.26}Fe_{1.45}O_3$ | 35.339 | 8,417 | 10.4 | 7.7 ± 1.4 | 90.8 |
| **MW23** | γ-$Zn_{0.29}Mn_{0.38}Fe_{1.33}O_3$ | 35.280 | 8,431 | 9.5 | 7.4 ± 1.6 | 83.6 |

## Figure S1. TEM images

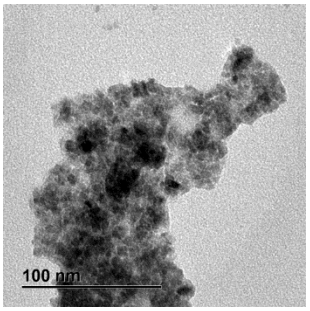
TEM pictures of the synthesized magnetic nanoparticles without citric acid coating.

**DEG**

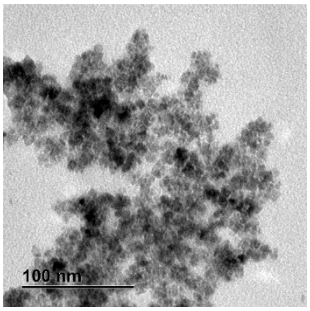
*MW10_MW01*



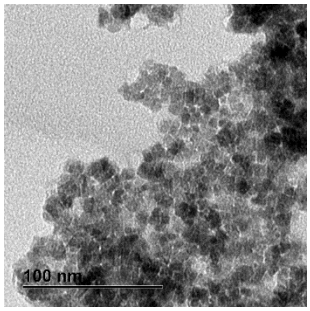

*MW1*



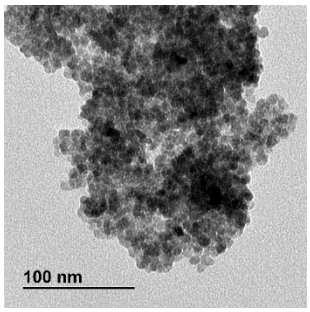

*MW5*



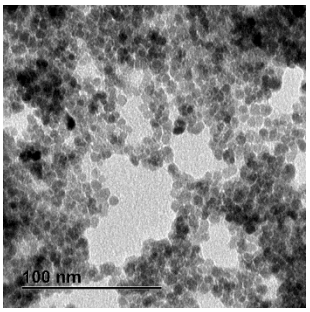

*MW2*



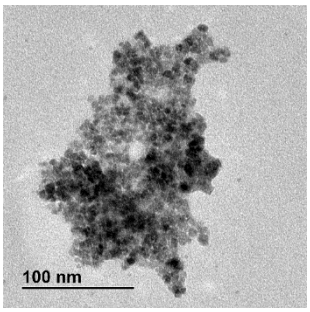

*MW3*



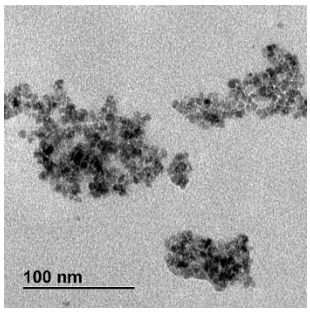

*MW4*



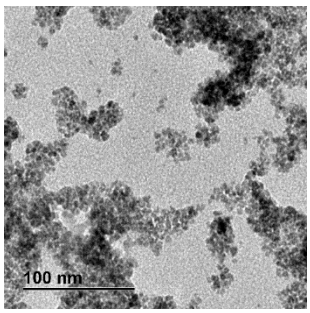

*MW6*



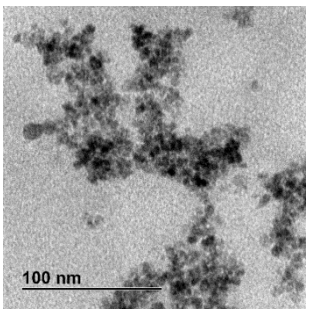

*MW7*




*MW8*

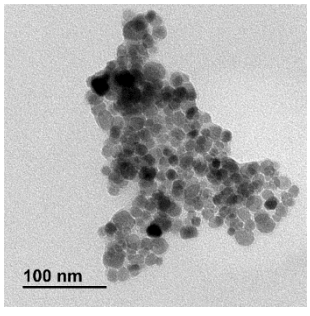



*MW9*

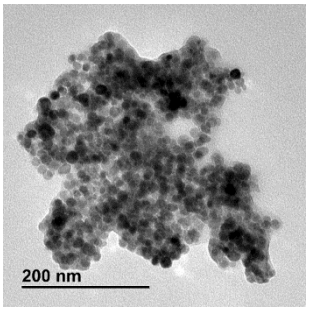



**TEG**

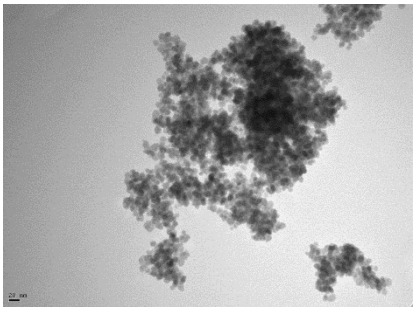
*MW15_MW11*



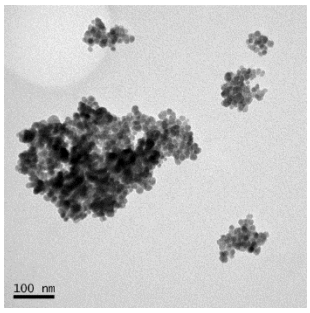

*MW15Z_MW12*



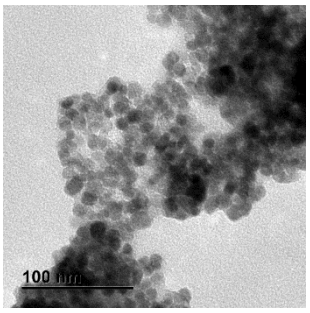

*MW10*



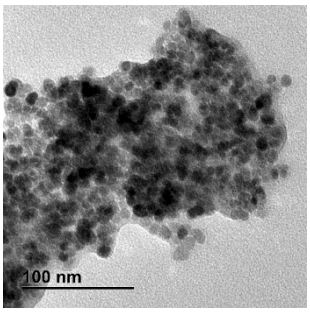
*MW13*



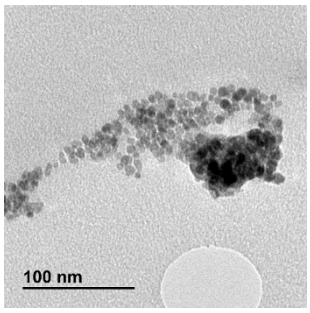

*MW14*



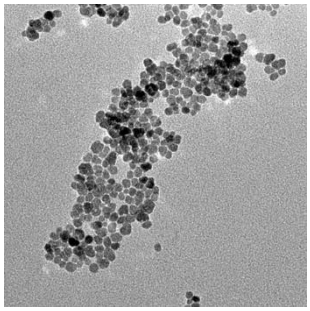

*MW15*



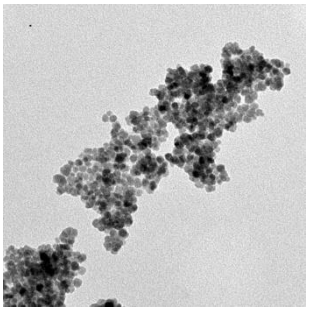

*MW16*



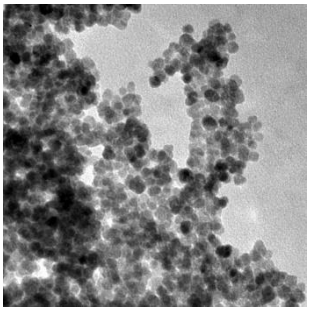

*MW17*



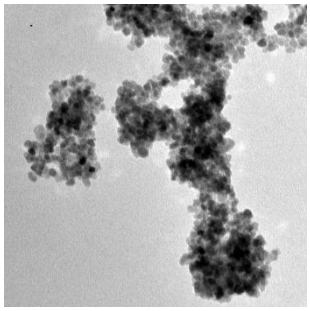
*MW18*



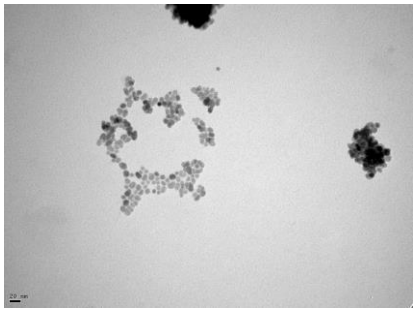
*MW19*



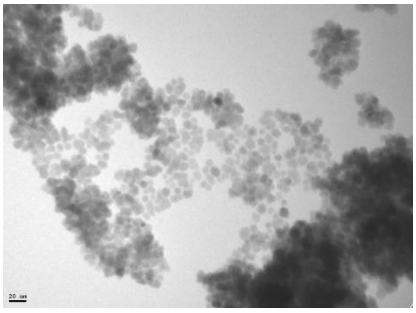
*MW15Z_MW20*



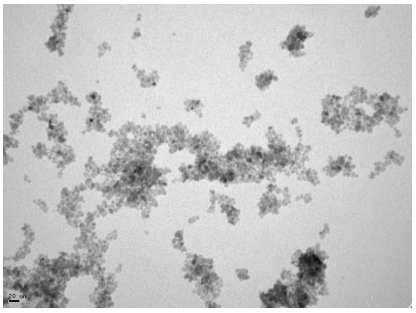
*MW21*



*MW22*

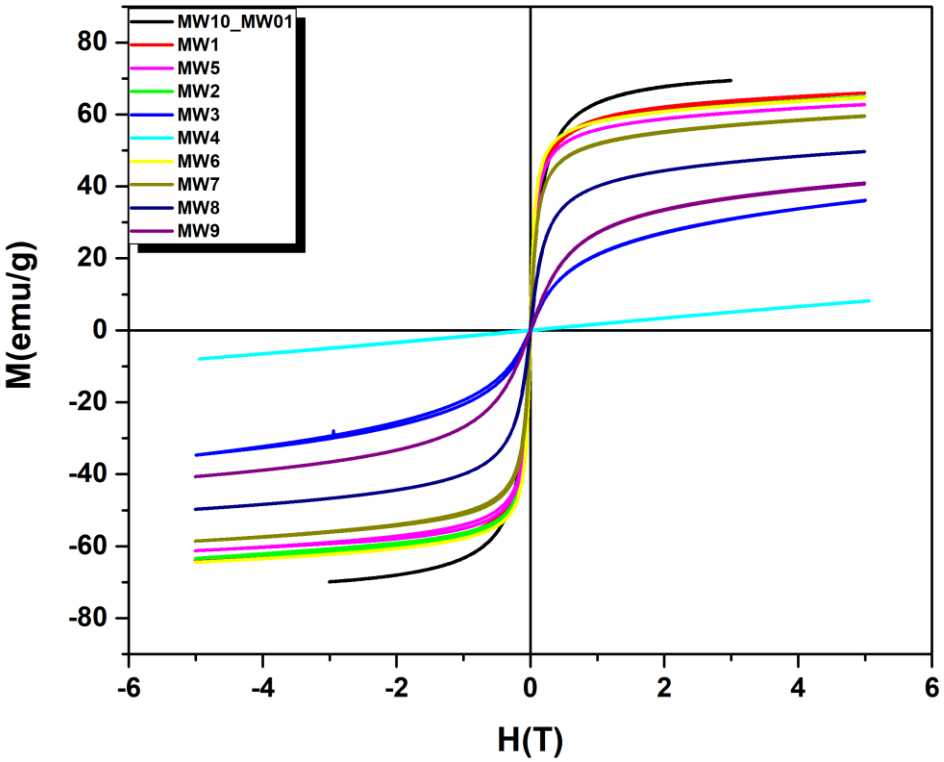


*MW23*

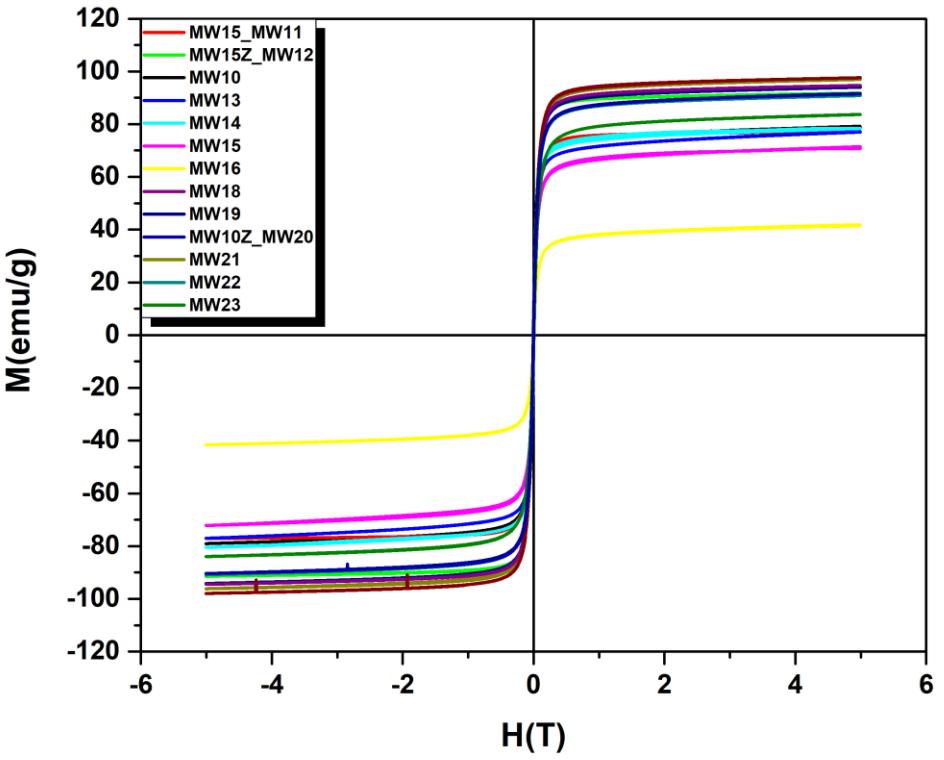


## Figure S2. Hysteresis loops at 290 K

Hysteresis loops of the samples acquired at room temperature through a VSM.



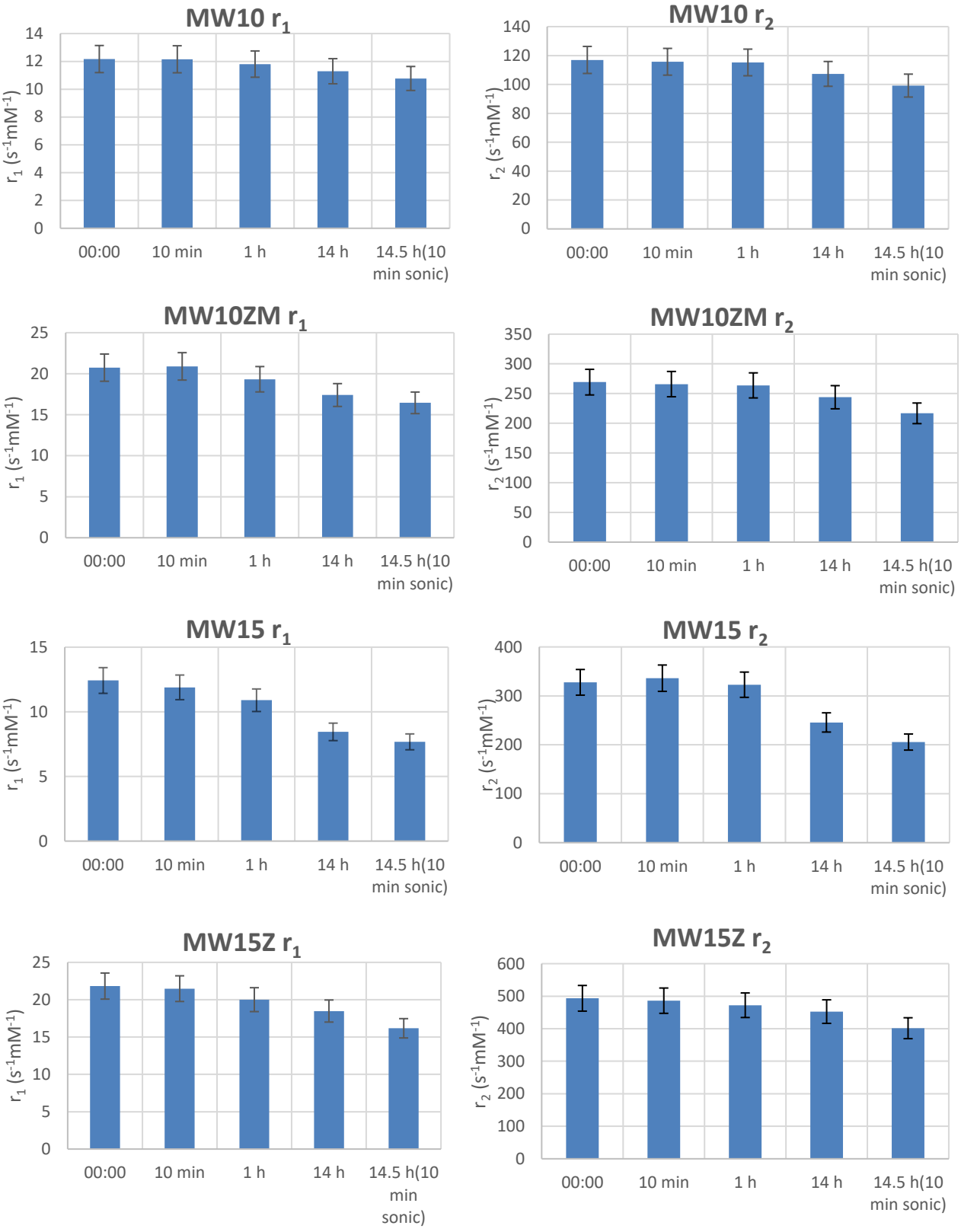

*Hysteresis loop at room temperature for samples synthetized with DEG.*




*Hysteresis loop at room temperature for samples synthetized with TEG.*

Figure S3. Stability vs time (A)

Here the longitudinal and transverse relaxation rates of the reference samples coated with citric acid and dispersed in 0.15 mM water solutions, measured in time. The last points are acquired after 10 minutes of sonication.



## Figure S4. Stability vs time (B)

Here the longitudinal and transverse relaxation rates of the reference samples coated with citric acid and dispersed in 0.15 mM water solutions, measured in time. The last points are acquired after 2.5 minutes of sonication.

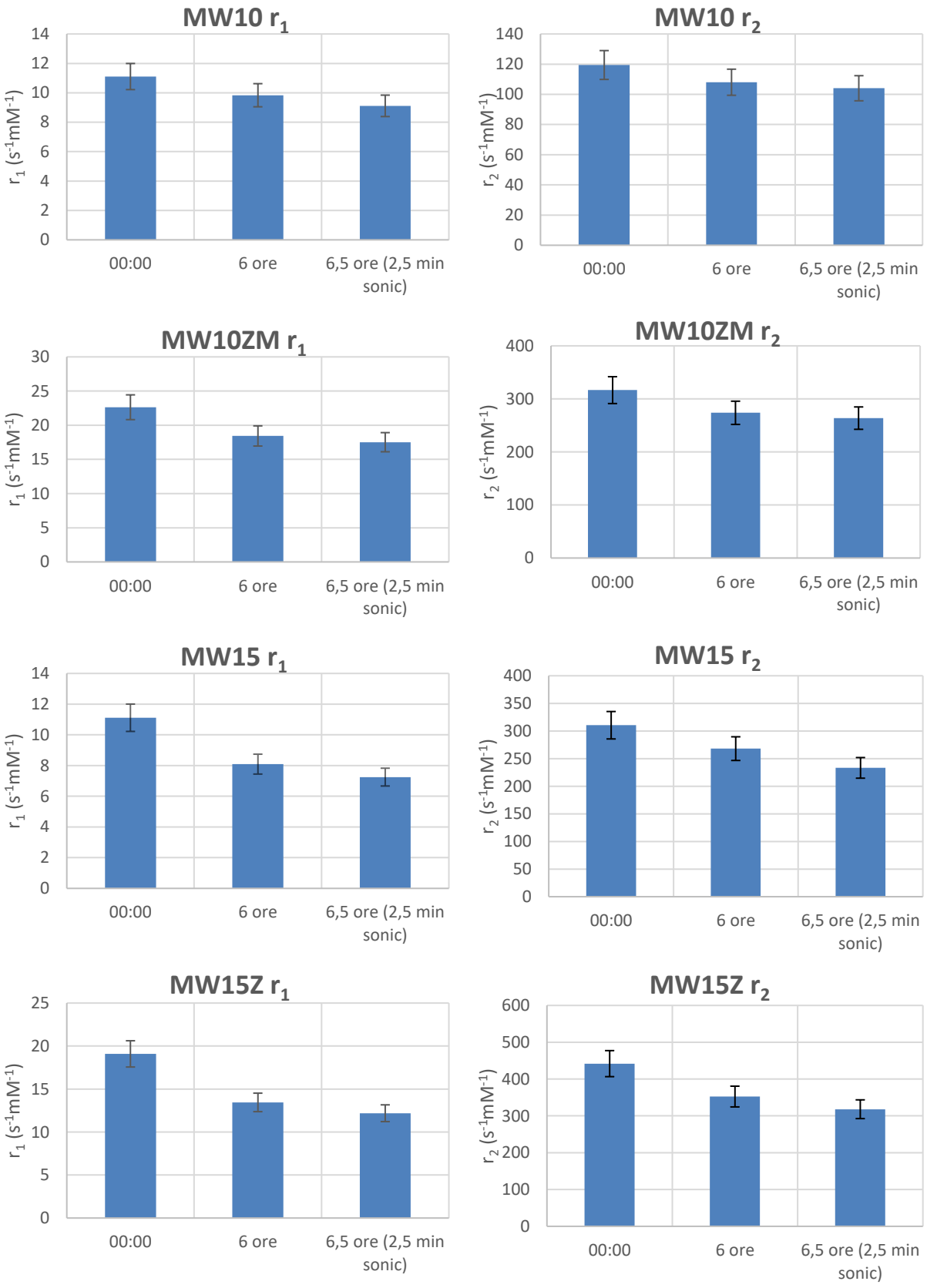


Figure S5. Stability vs time (C)

Here the longitudinal and transverse relaxation rates of the reference samples coated with citric acid and dispersed in 0.15 mM water solutions, prepared from the former solution once a month for three months.