Electronic Supplementary Material (ESI) for RSC Advances.

Polarization Enhanced Multi-grains Boundaries Dendritic Micro-nano Structure α-Fe for Electromagnetic Absorption Application: Synthesis and Characterization

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Figure of contents

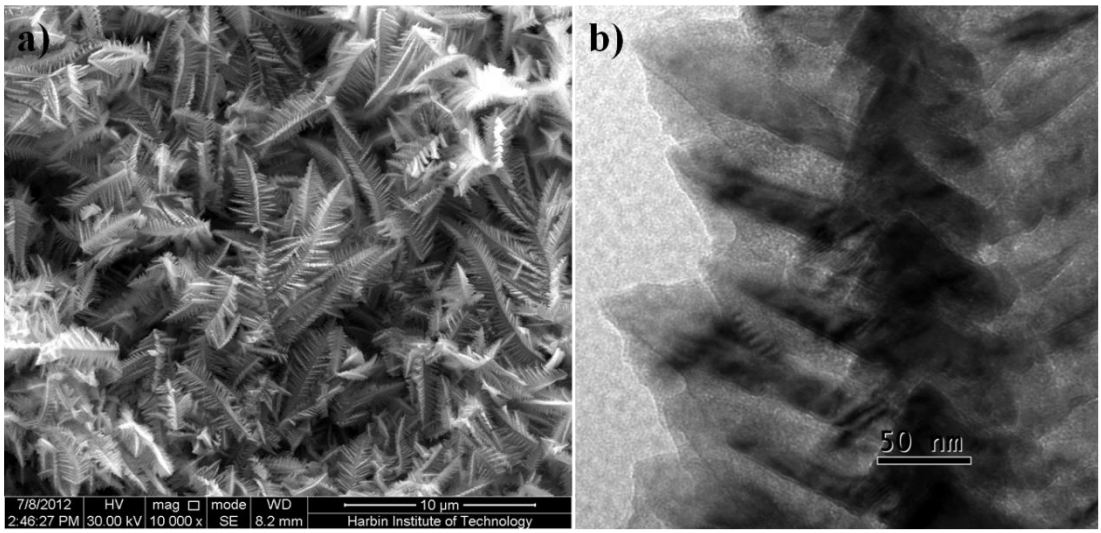

Figure S1. a) **S**EM and b) TEM images of pure dendritic micro-nano α-Fe fractals

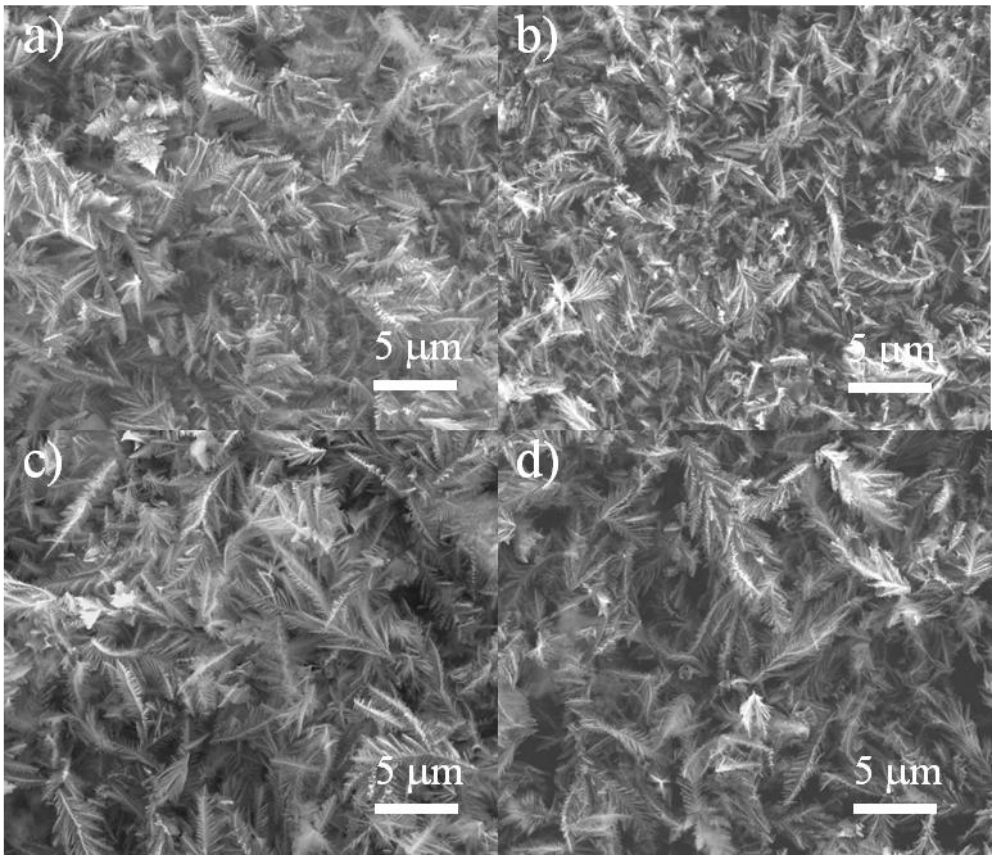

Figure S2. Electron microscopy images of RE-added dendritic micro-nano α-Fe fractals: a) Fe-2La, b) Fe-3La, c) Fe-2Ce and d) Fe-3Ce

From Figure S1, it can be known that structures of La-added and Ce-added dendritic micro-nano α-Fe samples become more and more irregular and disordered with the increase of RE ions concentration. More and more refined and complicated structures generate. Meanwhile, their sizes obviously decrease.

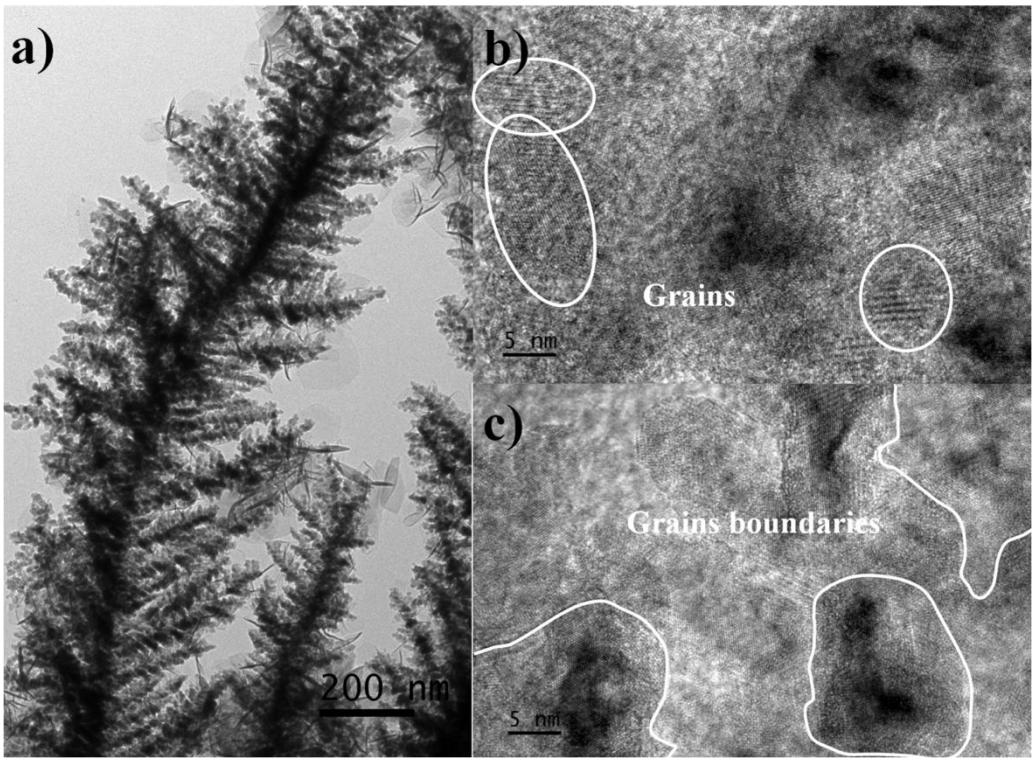

Figure S3. a) TEM image of the dendritic structure samples and the HRTEM images taken from the branches of b) Fe-4La and c) Fe-4Ce dendritic structure samples

These images show that there are a lot of nanosized α-Fe crystal particles on the surface of branches. We propose that the RE ions lead to the generation of nanosized α-Fe particles which could suppress the growth of dendritic α-Fe, and further decrease the size. Furthermore, this kind of accumulational surface structure is contributed to the generation of grains boundaries (in Figure c)). Therefore, the more RE ions added the more grains boundaries and smaller the size. The excellent electromagnetic absorption performance benefits from this unique surface structure which facilitate strengthening the free electronic polarization and interfacial polarization to a great extent.

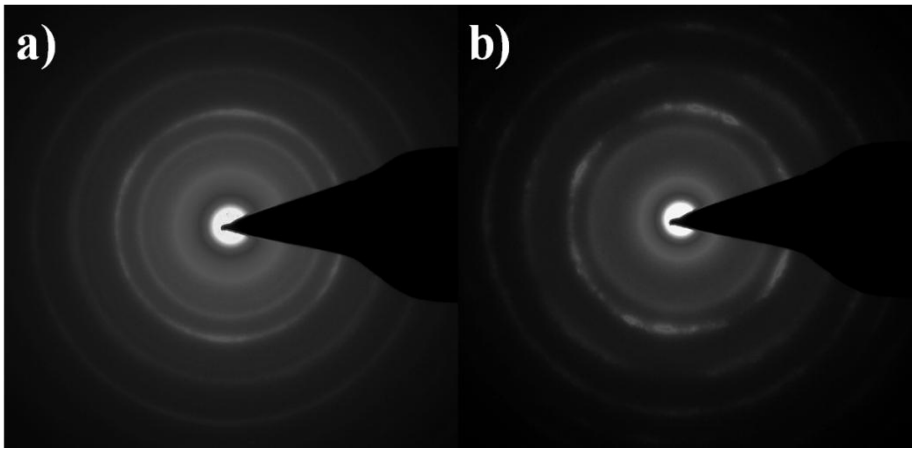

Figure S4. SAED patterns of dendritic structure a) Fe-4La and b) Fe-4Ce samples.

The diffraction ring patterns assign to the polycrystalline structure of RE-added α-Fe samples.

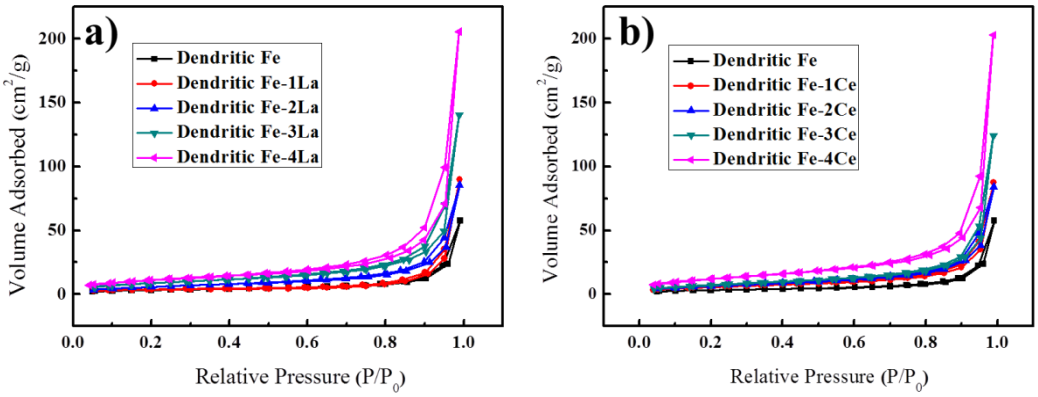

Figure S5. N_2 adsorption-desorption isotherms of a) La-added and b) Ce-added dendritic micro-nano structure α-Fe compared with the unadded dendritic α-Fe.

The shape of N_2 adsorption-desorption isotherms prove that the tested samples are nonporous materials in agreement with the structure of dendritic α-Fe. When the relative pressure is above 0.9, the volume of adsorbed N_2 increases linearly as the pressure becomes large, which indicate the occurrence of surface adsorption.

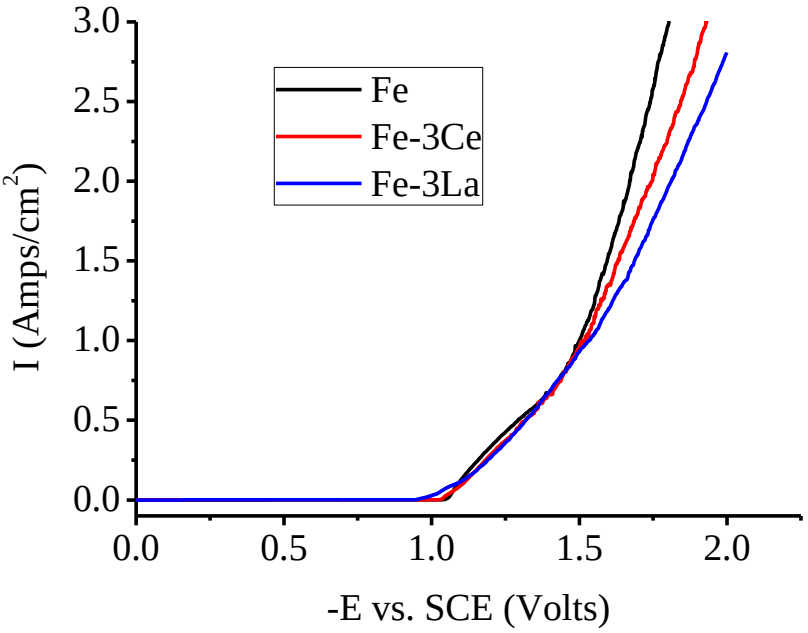

Figure S6. The cathodic polarization curves for different RE-added dendritic structure α-Fe.

The measurements were carried out in the cylinder electrolyser with the same solution concentration as what is used to prepare the dendritic α-Fe. The copper wire acts as the cathode, and annular steel electrode as the anode. The saturated calomel electrode (SCE) was put into the cathode area as the reference electrode. Each curve was recorded from the rest (zero current) potential into more negative potentials with the scan rate of 1.0 mV/s.

Table S1. La and Ce Content of RE-added dendritic micro-nano structure α-Fe synthesized in electrolyte with different RE ions concentration.

Sample ID	$La(NO_3)_3 \cdot 6H_2O$ concentration (g/L)	La Cnotent in samples (*wt*.%)	Sample ID	$Ce(SO_4)_2 \cdot 4H_2O$ concentration (g/L)	Ce Cnotent in samples (*wt*.%)
Fe-1La	0.25	0.10148	Fe-1Ce	0.25	0.11956
Fe-2La	0.50	0.19216	Fe-2Ce	0.50	0.22576
Fe-3La	1.00	0.35074	Fe-3Ce	1.00	0.42510
Fe-4La	2.00	0.62999	Fe-4Ce	2.00	0.77789

The content of RE elements is extremely low, and cannot be detected by EDS-SEM and EDX-TEM. So we studied them by the ICP-OES. Obviously, the RE contents in the samples increase with the increase of their concentration in electrolyte, which reflect that they play a role in suppressing the deposition of Fe^{2+}. Meantime, we propose that the tiny amounts of RE ions may be reduced and exist on the grain boundaries compounded with Fe under the effect of electric field.

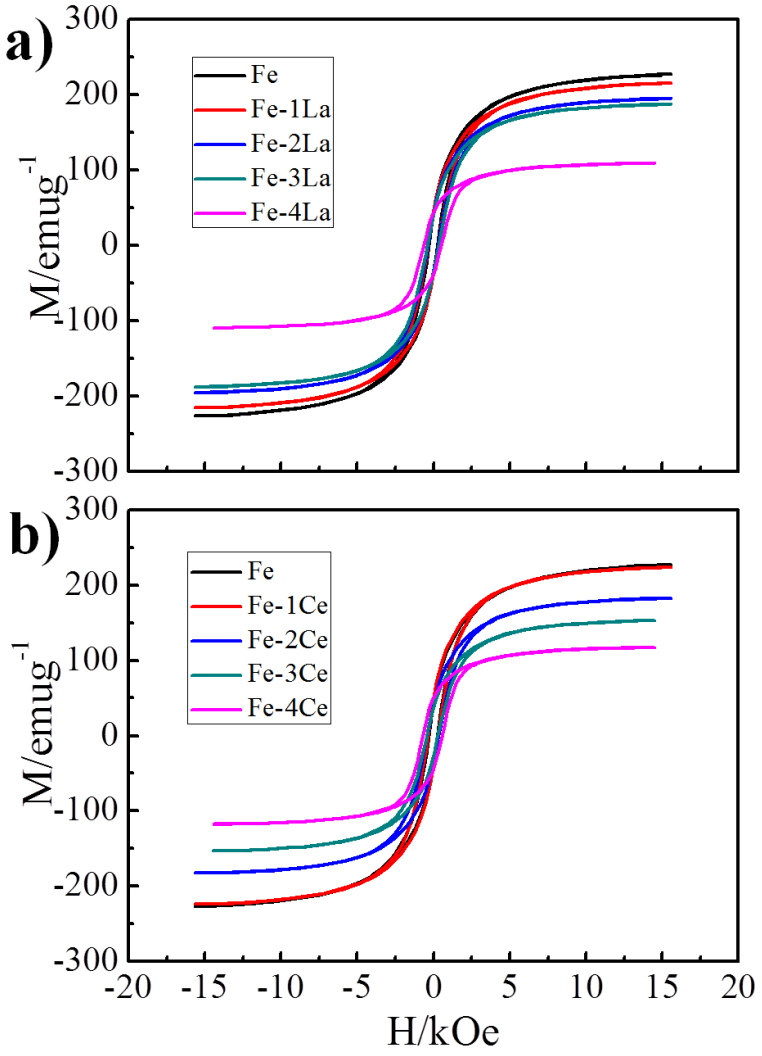

Figure S7. Magnetic hysteresis (*M-H*) loops of a) La-added and b) Ce-added dendritic micro-nano structure α-Fe.

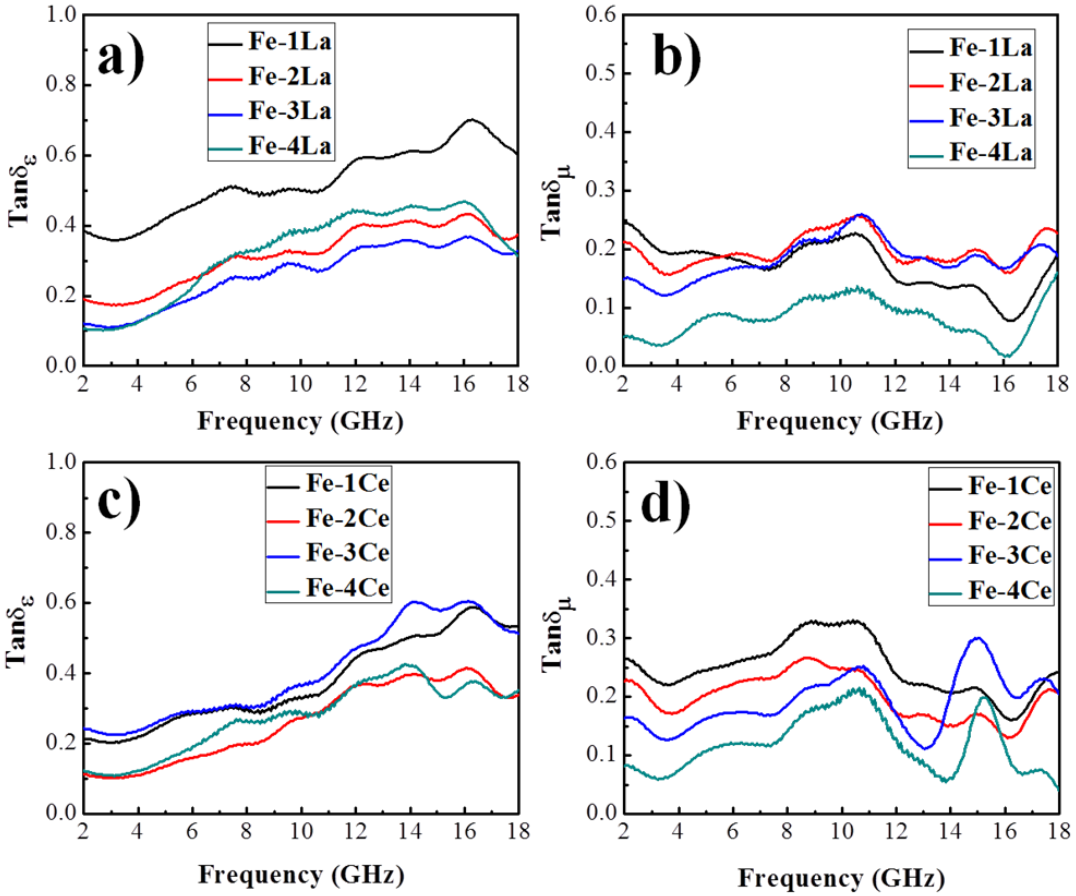

Figure S8. Dielectric loss tangents ($\tan\delta_\varepsilon=\varepsilon''/\varepsilon'$) and magnetic loss tangents ($\tan\delta_\mu=\mu''/\mu'$) of a-b) La-added and c-d) Ce-added dendritic micro-nano structure α-Fe under different frequency.