Electronic Supplementary Material (ESI) for Soft Matter

Behaviour of Iron Oxide (Fe_3O_4) Janus Particles in Overlapping External AC Electric and Static Magnetic Fields

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Supporting Information

Fig. S1 shows the assembly behaviour of Fe_3O_4-capped Janus particles when first exposed to a parallel static magnetic field (Fig. S1A) followed by an AC electric field in parallel field geometry. The chain shrinks upon application of the AC electric field by ~1% as a result of closure of the small gaps between adjacent particles on the same side of the chain (Fig. S1C and D).

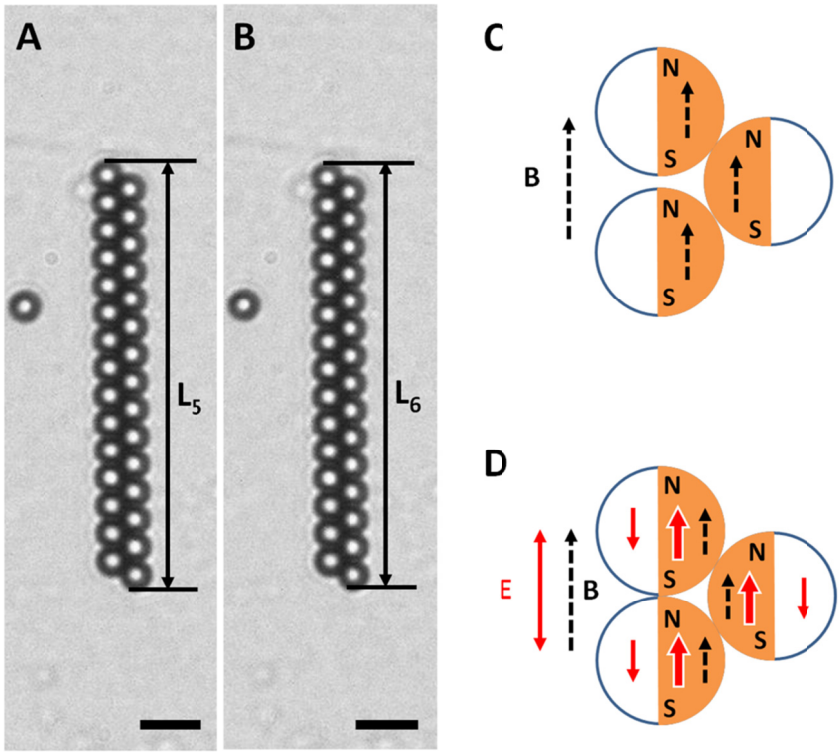

Fig. S1. Fe_3O_4-capped Janus particles in parallel static magnetic and AC electric fields. A) Double chain formed under applied static magnetic field (B = 0.08 T) with length of L_5 = 37.9 µm. The particle to the left of the chain is not part of the chain and is included for reference. B) 1% shorter double chain after application of a parallel AC electric field (V_{AC} = 187.5 V, f_{AC} = 75 kHz) with length of L_6 = 37.5 µm. C) Schematic of magentic dipole orientation causing double chain formation in magnetic field. Color scheme same as in Figure 3. D) Schematic of electric and magnetic dipole orientations in parallel static magentic and AC electric fields. Scale bars correspond to 5 µm.

Video S1. Video corresponding to the still images shown in Fig. 3 for parallel AC electric and static magnetic field assembly for Fe_3O_4-capped Janus particles. One staggered chain initially formed under AC electric field is shown. At t = 00:03 the static magnetic field is applied parallel

to the AC electric field. The chain immediately shrinks to a double chain with θ_2. The frame rate of the video is 0.5X that of the original recording rate (10 fps).

Video S2. Video corresponding to the still images shown in Fig. 4 for perpendicular AC electric and static magnetic field assembly for Fe_3O_4-capped Janus particles. One chain formed under the initially applied AC electric field is shown (field is applied in vertical direction of image). At t = 00:01, the static magnetic field is applied perpendicular to the AC electric field, the chain rotates around its long axis. Note, the blurring is caused by the shift in focus due to the physical insertion of the U-shaped magnet. At t = 00:06 the top chain begins to step off. At t = 00:11 the other end of the top chain begins to step off. At t = 00:13 the conversion is complete for the chain. The frame rate of the video is 2X that of the original recording rate (10 fps).

Video S3. Video corresponding to the still images shown in Fig. 5 for perpendicular static magnetic and AC electric field assembly for Fe_3O_4-capped Janus particles. Two double chains and a doublet formed under initially MF application are shown (magnetic field points from bottom to top). At t = 00:01, the AC electric field is applied perpendicular to static magnetic field, the chains rotate and, the drifting begins. At t = 00:09 the second chain stacks with the first one, while a third chain comes into the field of view. At t = 00:15 the third chain attaches to the end of the second chain and stacks with the first. The frame rate of the video is 2X that of the original recording rate (10 fps).

Video S4. Video corresponding to high-speed video image sequence shown on Fig. 7 for metastable chain obtained during perpendicular AC electric and static magnetic field assembly for Fe_3O_4-capped Janus particles. The AC electric field (field is applied in horizontal direction of image) is turned off at t = 00:02 before the chain has a chance to start the “step-off” process. The

chain immediately relaxes and buckles. At t = 00:03, the rotation of individual particle caps towards each other is observed throughout the chain. At t = 00:05, the chain breaks into small segments, which then rotate and align with perpendicular static magnetic field (field points from bottom to top) in a manner similar to the one observed when a static magnetic field is applied to an Fe_3O_4 Janus particle suspension. The frame rate of the video is 0.1X of the original recording rate (500 fps).

Video S5. Video corresponding to the still images shown in Fig. S1 for parallel static magnetic and AC electric field assembly for Fe_3O_4-capped Janus particles. One double chain formed under the initially applied static magnetic field is shown. At t = 00:01, the AC electric field is applied parallel to the static magnetic field and the chain shrinks by 1%. At t = 00:03 the AC electric field is removed and the chain expands by 1%. At t = 00:04 the AC electric field is reapplied and the chain shrinks again by 1%. At t = 00:05 the AC electric field is removed and the chain expands by 1%. The frame rate of the video is the same as the original recording rate (10 fps).