TUNING CRACKS BY EXPLOITING THE SHAPE OF PARTICLES AND EXTERNAL MAGNETIC FIELD

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Drying of a colloidal dispersion usually leads to the formation of particulate film with random cracks. The cracks in particulate film can have periodic arrangement with tuneable spacing and are known to be useful for practical applications such as for fabrication of lithographic templates and nano-channels. Various methodology has been adopted to generate the parallel and ordered cracks, the common one is via applying an external field such as magnetic field or electric field. We report here the controlled manipulation of crack orientation for colloidal films consisting of magnetically active particle (hematite ellipsoids), using an external magnetic field. Drying sessile drop experiments are performed in the presence and absence of magnetic field and a coffee ring like particle deposits are observed. The dried region consists of circular cracks in the absence of field while linear cracks (along the chord of the ring) in the presence of field. Moreover, we found that the crack orientations can be systematically altered by tuning magnetic field strength. We conjecture that the competition between the hydrodynamic torque and magnetic torque experienced by the particles during the drying of colloidal dispersion decides the final orientation of the particles and the cracks. The alteration of crack direction by controlling the orientation of ellipsoids in the particulate films by application of magnetic field is presented in detail.
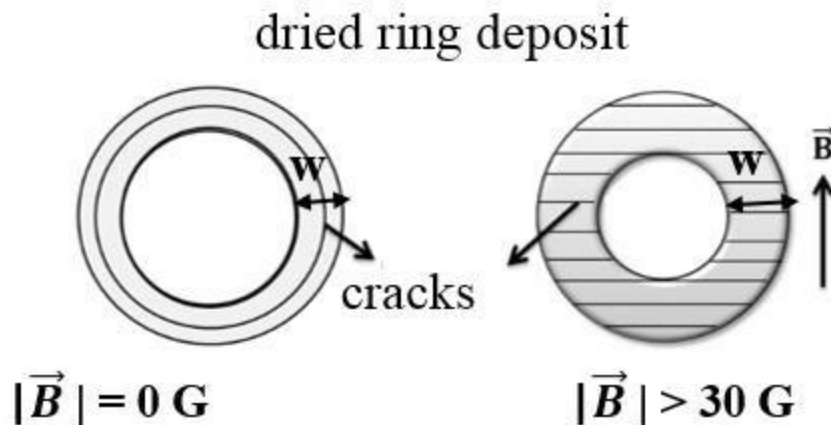
Figure 1 – Schematic of the dried ring like deposit with circular and linear cracks formed after complete drying a drop of colloidal dispersion at magnetic field $\vec{B} = 0$ & $\vec{B} = 30G$. The direction of magnetic field $\vec{B}$ and width of ring 'w' is marked in the figure.