FIELD-ASSISTED 3D PRINTING OF MULTIFUNCTIONAL MATERIALS

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The emergence of flexible, robust additive manufacturing platforms has created potentially transformative opportunities to integrate multiple functionalities: in particular, mechanical efficiency with mass transport, thermal management and conductivity. Field-assisted assembly of multi-phase materials holds promise for numerous applications, including flexible composites, patterning of cells in extracellular matrix in synthetic tissue, controlling ion transport in batteries, etc. Experiments involving acoustic field-assisted assembly of microscale particles will be used to elucidate the role of acoustic fields on structure formation, and the resulting opportunities to tailor macroscopic conductivity in novel ways. Figure 1 below illustrates results for conductive carbon fibers an elastomer matrix, with patterned lines created via acoustic focusing. A key advantage of the approach is the ability to create strong connected networks of second phase particles at volume fractions that are well-below that associated with the percolation threshold, which greatly facilitates the development of printable functional inks. In-situ and ex-situ observations of direct write printing will then be used to identify regimes that enable 'on-the-fly' control of microstructure during macroscopic patterning.

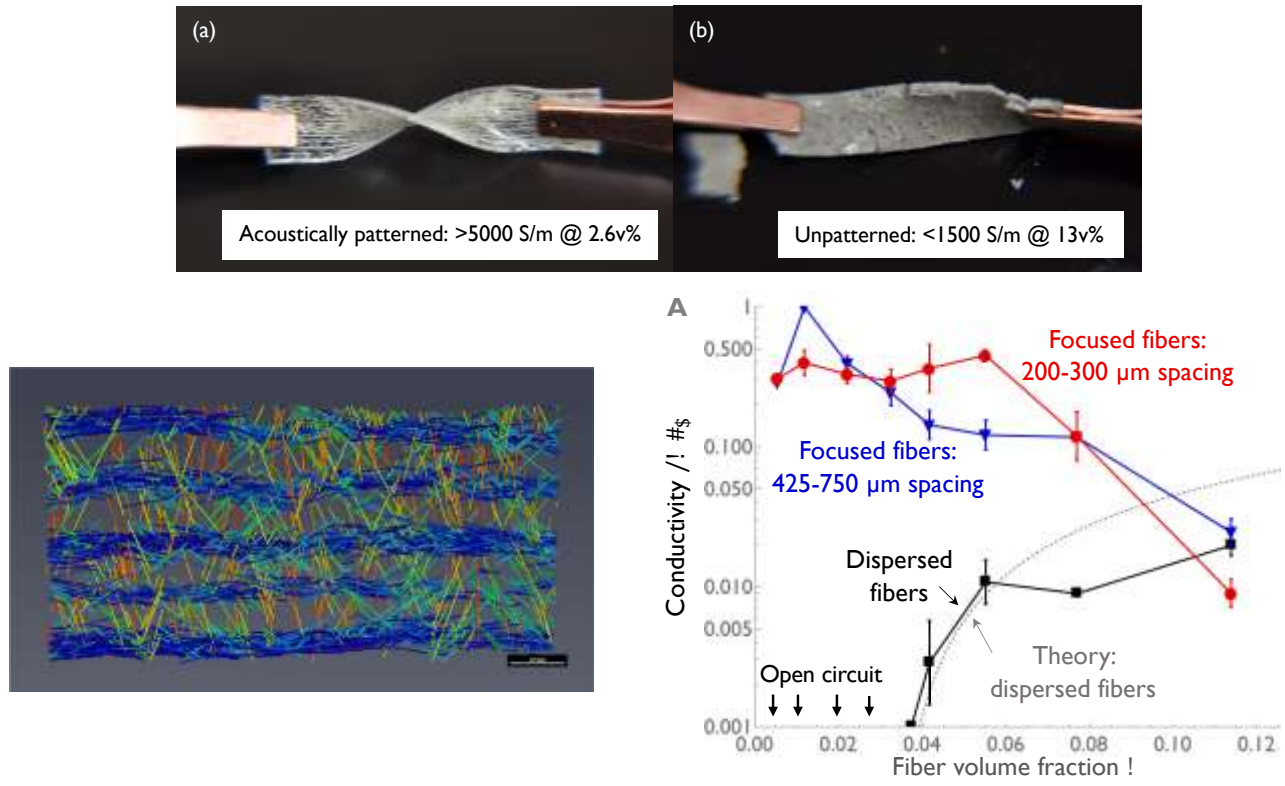

Figure 1 – Acoustic focusing allows on-the-fly alignment of conductivity particles, leading to (i) strong conductivity at volume fractions well below the percolation threshold (ii) decoupling between the mechanical properties of the matrix and particles.