Hyperuniform materials made with microfluidics

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The hyperuniform materials, being disordered systems with suppressed long-scale fluctuations, now attract a significant scientific interest, especially due to their potential applications for photonic materials production.

We study a jammed packing of oil droplets in water. The droplets are produced in a PDMS microfluidic chip by step emulsification coupled with T junction and directly assembled in a microfluidic channel. By varying the fluid pressures we manage to sharply control the droplet production and thereby govern the structural properties of the obtained material. The hyperuniformity of 3D and pseudo-2D (a monolayer of droplets) systems is investigated. Confocal microscopy is used to determine the position of droplets inside the material. Our results show that at appropriate experimental conditions the droplets self-organize in hyperuniform patterns both in 2D and 3D. The numerical simulations of electromagnetic wave propagation in the obtained materials also predict that they possess interesting optical properties, such as a photonic band gap (PBG). These results supports the hypothesis that hyperuniformity may lead to the PBG in disordered materials [1]. We hope that our studies will help to establish a new way of disordered photonic materials production.

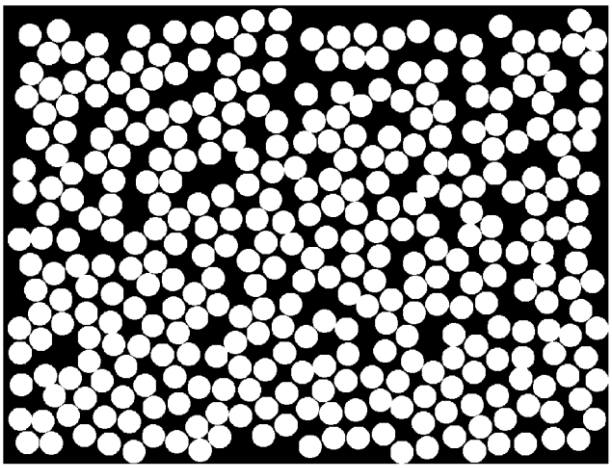

Figure 1 Reconstruction of confocal image.

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[1] M. Florescu, S. Torquato and P. J. Steinhard, *PNAS*, 2009, **106**, 49.