This talk covers multiscale characterization, evaluation, and design for adhesion dynamics of nanoparticles and cells. Nanoparticulate systems have been widely used in diagnostic imaging and targeted therapeutic applications in recent years. One of the major challenges in nanomedicine is to improve particle selectivity and adhesion efficiency under complex vascular flow conditions. We developed a immersed-boundary based multiscale computational fluid-structure interaction model and an integrated bi-layer microvascular mimetic microfluidic testing platform to evaluate nanoparticle targeted transport dynamics under vascular flow. A monolayer of endothelium cell is formed in the channel and activated locally through TNF-α to mimic the physiological diseased region. NP binding dynamics and vascular permeability under a range of shear rates are characterized to evaluate the targeting efficiency. We aim to provide a systematic design and evaluation tool toward a virtual vascular platform for nanomedicine testing.

Circulating tumor cells (CTCs) hold great promise for cancer diagnosis and prognosis, especially for early-stage cancer screening. Despite the significant progress in development of cell capture techniques, the capture efficiency is still limited and often accompanied with drawbacks such as low throughput, low selectivity, and cell viability issues. We designed a surface with both micro and nano features which significantly enhance capture efficiency and selectivity of cancer cells. A systematic study on the effects of micro pattern and nano pattern design on adhesion is performed on antibody functionalized PDMS surface. Micro-ripples of different wavelengths/amplitudes and nanopillars with different diameters are fabricated. Our hierarchical surface shows significantly improved CTC capture efficiency and purity.

Yaling Liu is an associate professor in the Mechanical Engineering and Mechanics department and Bioengineering Program at Lehigh University. Dr. Liu received his B.S. degree from Tsinghua University, and M.S and Ph.D. degrees from Northwestern University. After graduation, Dr. Liu worked as a senior engineer for a year at Seagate Technology. Dr. Liu has received several awards including: National Science Foundation (NSF) CAREER award, Ralph E. Powe Junior Faculty Enhancement Award. His research interests include: fluid-structure interaction, parallel computing, biotransport at the micro/nano scale, microfluidics, bioMEMS, cardiovascular fluid dynamics, bionano interfacial phenomena, nanomedicine, and biosensing.