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Microscale Thermal-Fluids: Still Plenty of Room at the Bottom

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Richard Feynman's iconic 1959 talk "There's Plenty of Room at the Bottom: An Invitation to Enter a New Field of Physics" articulated a vision of miniaturization in which fantastic mechanisms and processes could be realized. These included the creation of miniature swallowable surgical robots and arrays of macroscale machines that themselves create smaller scale machines, eventually leading to massively parallel microscale factories. Though scholars debate the direct impact of Feynman's talk on the development of micro/nanotechnology, no doubt the ensuing six decades have seen tremendous advances in the evolution of this vision. In the last three to four decades in particular we have witnessed tremendous progress in the advent of microscale thermal-fluid systems, including the development of microscale cooling mechanisms for microelectronics, "Lab-on-a-chip" technology for chemical and biological assays, DNA amplification, microscale heat exchangers, and micro-shocktubes to name just a few. In addition to the explosion of creativity and innovation sparked by the lack of off-the-shelf solutions at the microscale, we have experienced a renaissance of sorts of otherwise well-established fields/theories in thermal-fluids. In this talk, we will explore some of the milestones of microscale thermal-fluids so far as well as discuss the tremendous opportunities still awaiting us, not only in terms of microfabrication paradigms, but also—and perhaps more importantly—new approaches to analysis and modelling steeped in the fundamentals. Indeed, there is still plenty of room at the bottom.