Title: 3D Printed Evaporator Development for Loop Heat Pipes

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Abstract: The growing popularity of miniaturized satellites such as SmallSats and CubeSats, for commercial and scientific applications, has led to increased demand for low-cost and robust thermal management systems. Loop Heat Pipes (LHPs) with 3D printed evaporators have been under development at Advanced Cooling Technologies, Inc. with the goal of reducing manufacturing costs by eliminating several labor-intensive processes associated with standard evaporator fabrication and assembly. Using Direct Metal Laser Sintering (DMLS), the evaporator can be printed directly as an integrated structure with a porous wicked region with precisely positioned vapor grooves, and a fully-dense outer wall. The reported work describes the latest progress in DMLS evaporators in terms of primary wick advancement and thermal performance improvement. Following iterative optimization of the DMLS variables, the maximum pore size of the primary wick was reduced successfully to a sub-5-micron level, representing an over 40% improvement in the wick fineness during the reported period. A high-porous wick was also attempted using DMLS with the goal of minimizing the evaporator pressure drop during LHP operation. This wick was shown to have a ten-fold improvement in permeability as compared to the DMLS wicks attempted previously. The overall thermal conductance of the system was improved by over 15% using a new saddle design for the evaporator. The new 3D printed evaporator assembly, with an intermediate primary wick from the wick optimization routine, was shown to operate successfully at a steady-state power level of 350 W using ammonia as the working fluid.