MECHANICAL ENGINEERING

The Department of Mechanical Engineering presents:

The Master's Dissertation Defense of:

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Drop Impact Behaviors for Cooling Applications and Experimental Developments for Optical Cavitation

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Dr. Guillermo Aguilar, Chairperson

The cooling behavior of an impacting single droplet and train of droplets on a heated substrate (T = 60oC) for various pool conditions is explored. The effects of several variables such as impact velocity (1-4 m/s), droplet diameter (4.8 mm), pool depth (0-34 mm), and impact frequency (0.5-32 Hz) on the cooling dynamics are explored. Fast response resistance temperature detectors (RTD) embedded at the surface of the substrate allows for temperature measurement below the droplet impact. A high speed video camera recorded the dynamics of cavity formation and collapse upon impact with the pool surface. Droplet diameter and impact velocity were also measured using the high speed video. The instantaneous heat flux and net heat extraction at the surface were obtained using a finite-time step integration of Duhamel's theorem.

Heat transfer appears to be maximized within an intermediate region of impact Weber number for the single droplet impacts. At this intermediate Weber number range, the impact crater almost reached the pool bottom, suggesting that cold droplet fluid made contact with the substrate, maximizing the cooling effect. Outside this intermediate region of Weber number, the heat flux appears to decrease. At the higher Weber number range, cold droplet fluid is pushed away from the measurement point once the cavity reaches the substrate. Below the optimal range of Weber number, the droplet does not enter the crater formed by the previous droplet, preventing it from reaching the substrate. For a train of droplets, there seems to be several regions where the heat flux is further reduced due to collision of droplet with emerging jet. It was also found that dry surface provides better heat flux with the heat flux decreasing with formation of thin film.