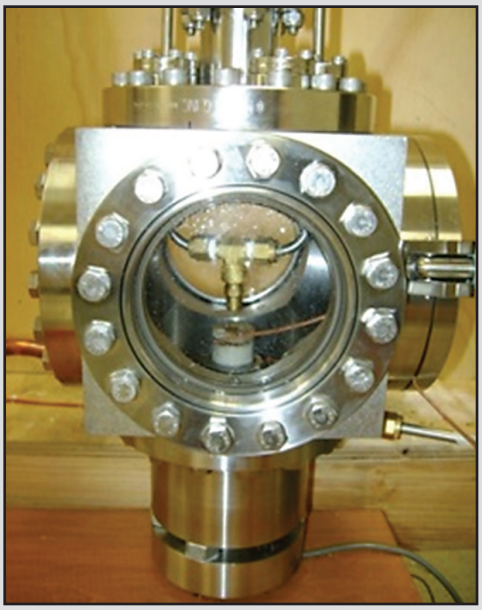
HBCU Research Nets Double-or-Nothing Heat Transfer



North Carolina A&T State University–developed spray chamber for testing technologies that could enhance high-heat-flux heat transfer. (AFRL image)

Addressing major challenges related to the high-heat-flux thermal management of current and future airborne tactical platforms (especially directed energy weapons), researchers funded through AFRL's Historically Black Colleges and Universities (HBCU) program developed novel surface-enhancement technologies that effectively double the evaporative heat transfer coefficient. Specifically, North Carolina Agricultural and Technical (NCAT) State University's Professor John Kizito and University of Central Florida's Prof Louis Chow led a team of a dozen students in investigating—and successfully demonstrating—the effects of microstructured surfaces on spray-cooling heat transfer.

Employing microscale indentations and protrusions on the heater surfaces, the researchers tested these microstructured surfaces in a closed-loop ammonia-vapor-atomized spray chamber developed specifically for the effort. They observed that at 500 W/cm2, the heat transfer coefficient increase for protrusions and indentations (as compared to smooth surface) was 112% and 49%, respectively. Moreover, their results indicate that smooth surface yields nearly identical cooling curves in the heating-up and cooling-down modes, while microstructured surfaces experience a hysteresis phenomenon that generates lower surface superheat in the cooling-down mode. These details are recorded in the Journal of Heat Transfer publication, Volume 131, 2009. The joint team also carried out an experimental study investigating the nucleate boiling and critical heat flux (CHF) of water and FC-72 dielectric liquid on hydrophilic titanium oxide (TiO2)-nanoparticle-modified surface. The results reveal that the TiO2-coated surface increased CHF for water and FC-72 by 50.4% and 38.2%, respectively. These findings display in the International Journal of Heat and Mass Transfer, Vol 53, 2010.

With respective backgrounds in fluid dynamics/heat transfer and high-heat-flux spray cooling, Profs Kizito and Chow each brought unique and complementary expertise to the team. Of equal import to the pair's significant technical feats, however, is their overall contribution to the lab-funded NCAT program's graduation of nine African-American students (four females, four with master's degrees, and one PhD)—an exemplar of true HBCU program spirit.