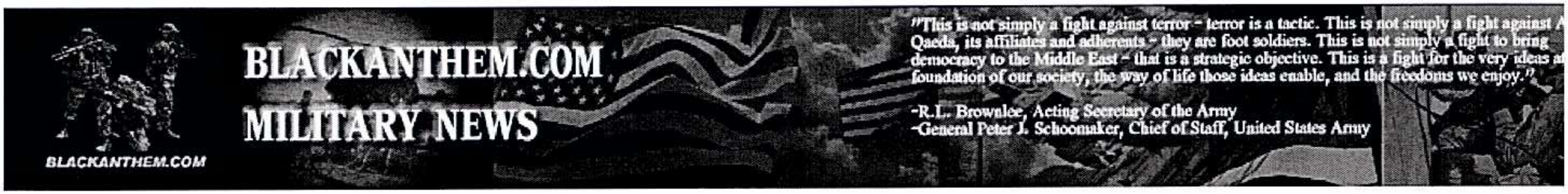

Sci/Tech

Thermal barrier coatings research could extend jet engine life

By Erin Crawley, Air Force Office of Scientific Research Public Affairs
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Blackanthem Miliary News, ARLINGTON, Va. — A team of Princeton University scientists and engineers, funded by the Air Force Office of Scientific Research here, are paving the way for the development of new and improved thermal barrier coatings (TBC) that could increase the lifetime of jet engines. To make their predictions, the team developed and used state-of-the-art computer simulation models.

Professor Emily Carter, who presented the results at a recent program review, is the principal investigator on the project. Her research team is comprised of scientists and engineers from five different departments at Princeton, including: Mechanical and Aerospace Engineering, Applied and Computational Mathematics, Chemical Engineering, Electrical Engineering, and Chemistry.

In her presentation synopsis, professor Carter explained that aircraft engine components are protected by a multilayer, multi-component TBC, consisting of a NiAl-based alloy layer onto which is deposited yttria-stabilized zirconia. A layer of alumina grows between these two materials during zirconia deposition which thickens during engine use and limits the lifetime of the engine. According to professor Carter, most current TBCs fail after about 16,000 hours of thermal cycling.

"These coatings don't last forever, which means that essentially you have to take the engine out of service; you have to reapply the coating o replace parts," said professor Carter. "From a logistical point of view certainly it would be nice to extend the lifetime of these coatings."

The team then took steps toward solving the problem.

"In order to extend engine service life, it is critical to first understand mechanisms of failure, and then to use insights to design circumventior strategies," said professor Carter.

Using AFOSR grant money to support her proposal, "High Temperature Evolution and Multiscale Modeling of the Roles of Impurities and D on Thermal Barrier Coating Failure," professor Carter and team first conducted some fundamental calculations which revealed the weak links in coating along with some characteristics of how the coating falls apart.

"We are looking at the atomic scale and trying to understand what are the chemical and physical properties [of the multi-layered coating] that lead to the failure of this coating. We figured out what part of the coating fails and why," said professor Carter. After which, the team set out to engineer a new coating based on their findings. The team did this by essentially inserting different kinds of atoms at the weak link they had disc in the coating, explained professor Carter.

As the research continued, professor Carter's team verified their findings.

"We showed on the computer that our hypothesis was verified. In other words, we showed that these re-designed coatings were much more s said professor Carter.

The next step is to find out how these coatings respond to high temperatures.

"It would also be really nice to make it so that these coatings are more robust at higher temperatures so that you could use them for faster airp with higher thrust and greater fuel efficiency," she said.

Over the years professor Carter has received a variety of AFOSR grants to support her research. Much of the groundwork for Carter's curren project evolved from AFOSR funded research she conducted while at the University of California – Los Angeles (UCLA) between 1988 and 20