Air Force
Research Laboratory|AFRL
Science and Technology for Tomorrow's Aerospace Forces

Materials and Manufacturing Directorate

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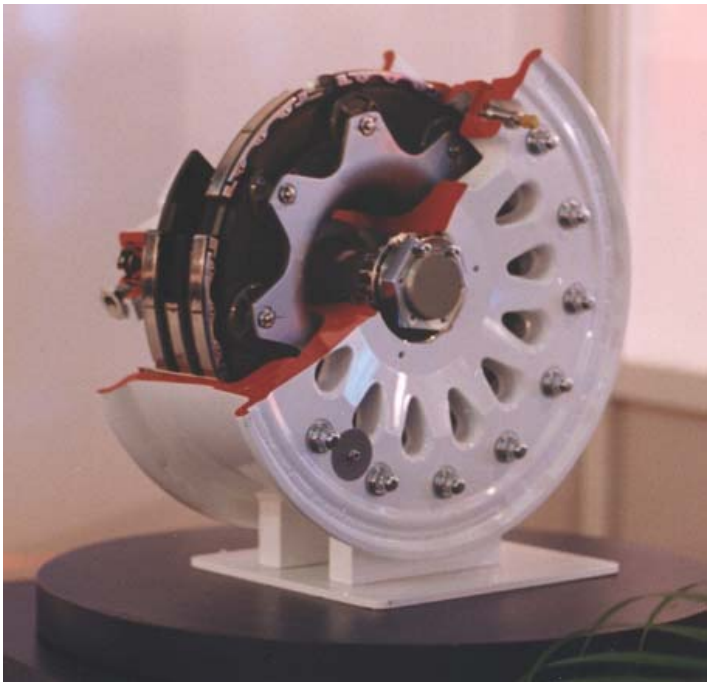
Ceramic Brake Disks

Air Force researchers, in projects at the Air Force Research Laboratory Materials and Manufacturing Directorate (AFRL/ML), are developing materials for aircraft brakes that may be used in the future for high performance automobile brakes.

Aircraft brakes are configured with multiple disks (typically five to seven disks) which are squeezed together hydraulically when the brake is applied. Every other disk is a rotor, which rotates, and the stationary disks are called stators. The outer disks are the end plate and pressure plate, respectively, and are only rubbed on one face. The material currently used for these disks in high performance aircraft brakes is carbon fiber reinforced carbon (C/C), though many older systems and some current commercial systems still use steel (it is heavy, but it also is cheap).



Aircraft brake

Scientists and engineers in AFRL/ML are working on application of new materials for aircraft brakes, which have the potential for reduced wear (to last longer) and for a higher and more stable friction coefficient. They also have potential for improved environmental stability and reduced brake weight and/or volume. The ceramic matrix composites (CMCs) being optimized for these brake applications are carbon fiber reinforced silicon carbide (C/SiC) and carbon fiber reinforced boron carbide (C/B4C). In aircraft brake operations, these materials could result in a more rapid operational turn time, i.e., when the brakes get hot and must cool to acceptable limits before the aircraft can be refueled. There may be such an advantage with the CMCs, versus C/C materials.

C/SiC is currently being demonstrated for a variety of applications in rocket engines and thermal protection systems. It is in production for high-end vehicles available from Porsche, Ferrari, and Mercedes. C/B4C is not currently being used commercially, but it has thermal properties which make it desirable for brake applications. In addition to high-end vehicles, C/SiC has been considered for use in Europe on high-speed trains and for auto and motorcycle racing applications.

While there are no specific problems with the currently used C/C material for aircraft brakes, this material is expensive and has a variable friction coefficient, leading to "morning sickness" (low friction coefficient with a cold, damp brake) and brake fade under rejected takeoff conditions.

If the new CMC materials are successful in aircraft applications, the technology would likely be transferred to automotive applications as well.