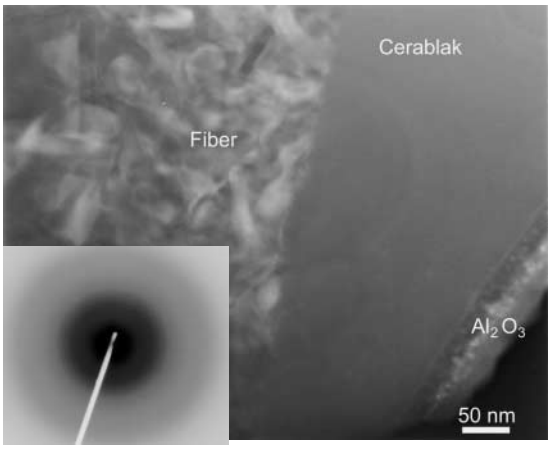
# Cerablak™ Overview

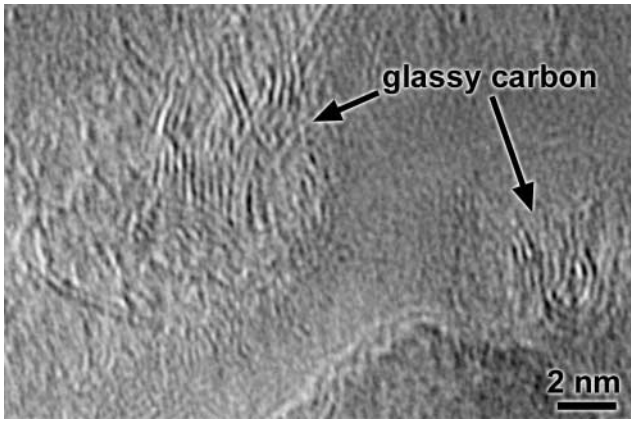
Cerablak™ is a newly discovered amorphous/glassy material, based on aluminum phosphate compositions, derived using a nanoscale-designed chemical precursor solution. Based on its unique characteristics and demonstrated performance, Cerablak™ represents a new development in ceramic/glass science with excellent commercial potential for a broad range of applications to include corrosion protection, hydrophobic/non-wetting/non-stick surfaces, high temperature oxidation protection, high emissivity coatings, protection for molten metal processing equipment, and protective coatings for bioceramic materials. Current product development efforts are targeted toward defense, energy, space, industrial, and consumer applications. A new family of nanocomposite films and materials can be produced with encapsulated nanoinclusions, within Cerablak™ matrix, of varying chemistries to induce/enhance desirable optical, mechanical, electrical, and chemical properties. Cerablak™ is resistant to crystallization above 1400$^{o}$C and can be synthesized as a) hermetic films on metal/alloy, glass, and ceramic substrates, b) nanocomposite powders, and c) fibers, coatings, and matrices for CMCs. Using a low-cost, low-viscosity, and clear precursor solution, a dense, smooth, hermetic, and transparent film can be produced on substrates by dip/spray/spin/brush/flow coating techniques. A brief curing step above 500$^{o}$C is needed to form the thermally stable "glassy" coating material. The key attribute of Cerablak™ is its low oxygen diffusivity (chemical diffusivity estimated to be ~ 1 x $10^{-10}$ $cm^2$/sec at 1400$^{o}$C). In addition to high temperature oxidation protection, Cerablak™ has been shown to protect against molten salt corrosion.

ATFI is exploring various product development opportunities along with securing a strong intellectual property portfolio which includes two issued US patents (US 6,036,072 & US 6,461,415) and several pending US and international patent applications. Financial support from DOE, NSF, NASA, MDA, AFOSR, and industrial sponsors is gratefully acknowledged.

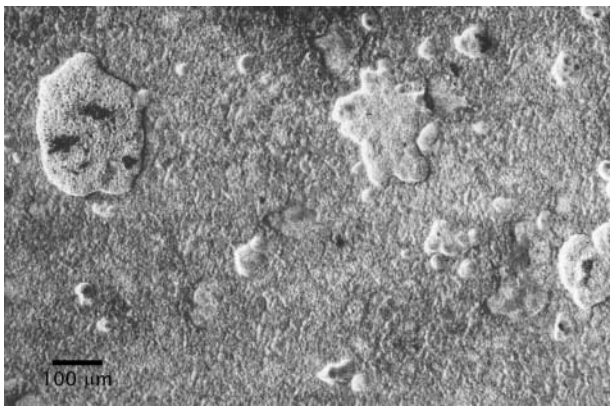

Uncoated (left) and Cerablak™ coated (right) stainless steel coupons (304) after anneal at 1000 °C for 100 hours in ambient air. The coating thickness was about 1 μm developed by a dip-coating process. Protection against high temperature oxidation has been demonstrated on Inconel, stainless steel, nickel and nickel alloys, nickel-based superalloys with bondcoat, titanium and titanium alloys, among others.

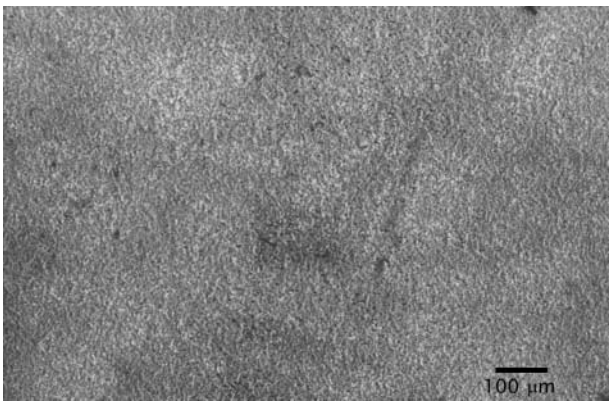



Excellent fiber strength retention properties have been demonstrated with Cerablak™ coatings on Nextel 610 and 720 fibers annealed to 1100C. Debonding at fiber/coating interfaces has been observed in minicomposites. TEM evidence demonstrating the thermal stability of Cerablak™ films produced on Nextel 610 fibers and annealed to 1200C for 100 hours in air is shown on the left.




Cerablak™ synthesized in powder form is usually black in color, as opposed to films which are transparent. The black color is attributed to the presence of nanosized carbon inclusions which are thermally stable, thus demonstrating Cerablak's compatibility with and ability to protect carbon from oxidation above 1400°C in ambient air. In addition, the carbon inclusions provide high emissivity, as well as enhancing the mechanical properties.




The presence of surface defects is known to accelerate the oxidation and corrosion of metals and alloys. Cerablak's™ hermetic nature seals these defects. The SEM micrographs above demonstrate its effectiveness. The islands on the uncoated material represent pitting corrosion, and are absent on the Cerablak ™coated material.