

Fiber Selection Guide

3M™ Nextel™ Industrial Fibers & 3M™ Nextel™ Composite Fibers

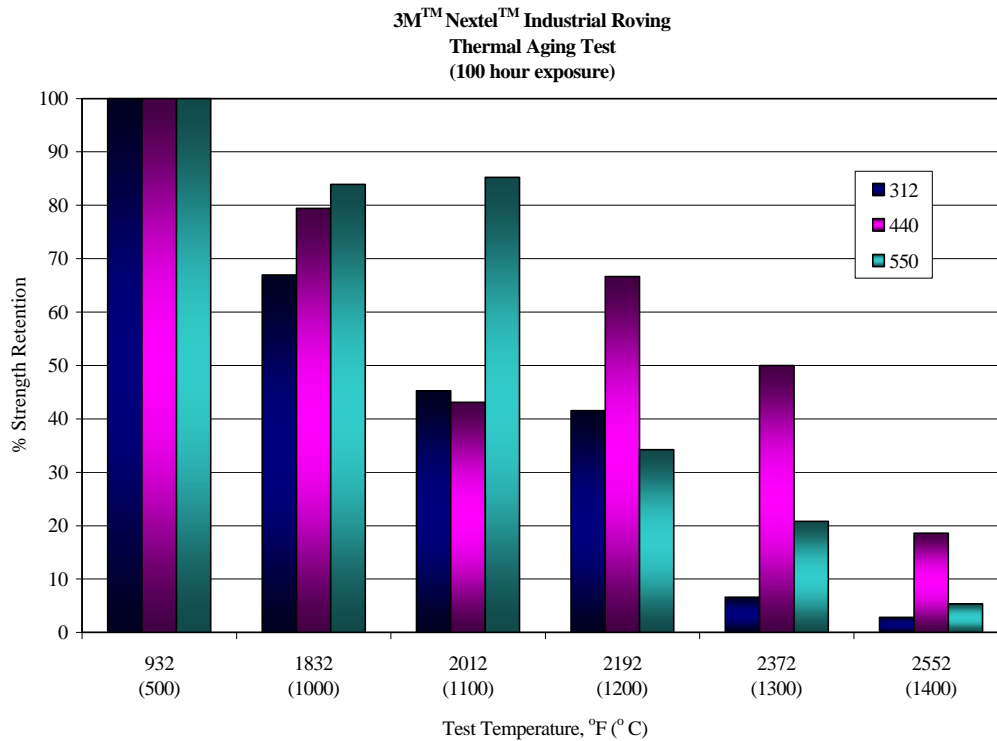
The family of 3M Nextel Fibers was developed to serve a variety of needs. 3M Nextel Fibers 312, 440, and 550 are designed for non-structural applications where their primary purpose is to insulate or to act as a flame barrier. 3M Nextel Fibers 610 and 720 are composite grade fibers designed for load bearing applications in metal, ceramic, and polymer matrices. To aid in the selection of the proper fiber for each of these different applications, the fibers are tested in a manner appropriate to their end use. The graphs that follow show the results of two different methods of testing fiber strength. In the thermal aging test, fiber break load is measured at room temperature after exposure at an elevated temperature for 100 hours. In the strength at temperature test, fiber break load and single filament tensile strength is determined while the fiber is held at temperature.

Two of the industrial fibers, 3M Nextel Ceramic Fibers 312 and 440, are made from Al_2O_3 , SiO_2 , and B_2O_3 at varying percentages. Because B_2O_3 is present, these compositions have both crystalline and glassy phases. The glassy phase helps the fiber retain strength after exposure to high temperature because it slows the growth of the crystalline phases that weaken the fiber. However, when the fiber is stressed at high temperature, the glassy phase weakens the fiber due to viscous flow much like a glass fiber. 3M Nextel Ceramic Fiber 550 does not contain B_2O_3 and therefore does not have a glassy phase. At exposure temperatures higher than 2192°F (1200°C), the strength of 3M Nextel Ceramic Fiber 550 is lower strength than 3M Nextel Ceramic Fiber 440 due to the formation of larger grained mullite. On the other hand, because 3M Nextel Ceramic Fiber 550 has no glassy phase it retains its strength better at temperature as is shown in the graph below where the roving is tested at temperature.

The composite grade fibers, 3M Nextel Ceramic Fibers 610 and 720, have more refined crystal structures based on $\alpha\text{-Al}_2\text{O}_3$ and do not contain any glassy phases. This allows the fibers to retain their strength at higher temperatures. The at temperature strength testing (3M Nextel Composite Fibers, % Strength Retention at Temperature, Single Filament) shows the effect of adding additional components to the fiber. 3M Nextel Ceramic Fiber 610 is a fine grained single-phase composition of $\alpha\text{-Al}_2\text{O}_3$. It has the highest strength at room temperature, thus making it well-suited for metal matrix composites. However, because it is essentially single phased, the strength rapidly decreases at higher temperatures due to grain growth (3M Nextel Ceramic Fiber 610 and 720 graphs of Strength Retention and Grain Size after 1000 hours Exposure). 3M Nextel Ceramic Fiber 720, which is $\alpha\text{-Al}_2\text{O}_3$ with SiO_2 added (forming $\alpha\text{-Al}_2\text{O}_3$ / mullite), has better strength retention at temperature due to reduced grain boundary sliding. This addition also helps to “pin” the grains and reduce grain growth when exposed to thermal aging as shown (3M Nextel Ceramic Fiber 610 and 720 graphs of Strength Retention and Grain Size after 1000 hours Exposure). Further confirmation of the effect of additional phases and removal of the glassy phase is shown in creep testing (3M Nextel Ceramic Fiber Creep Limit).

When selecting the fiber type for a particular application, it is important to consider all these factors. If the fiber/fabric will not have to support a load at temperature, the lower-cost industrial grade fibers may be appropriate. However, if the fiber will be load bearing at temperature, as in ceramic matrix composites, then one of the composite grade fibers would be a better choice. Other factors, such as corrosion,

chemical resistance, or atmospheric conditions may influence the final selection.



Outline of Test:

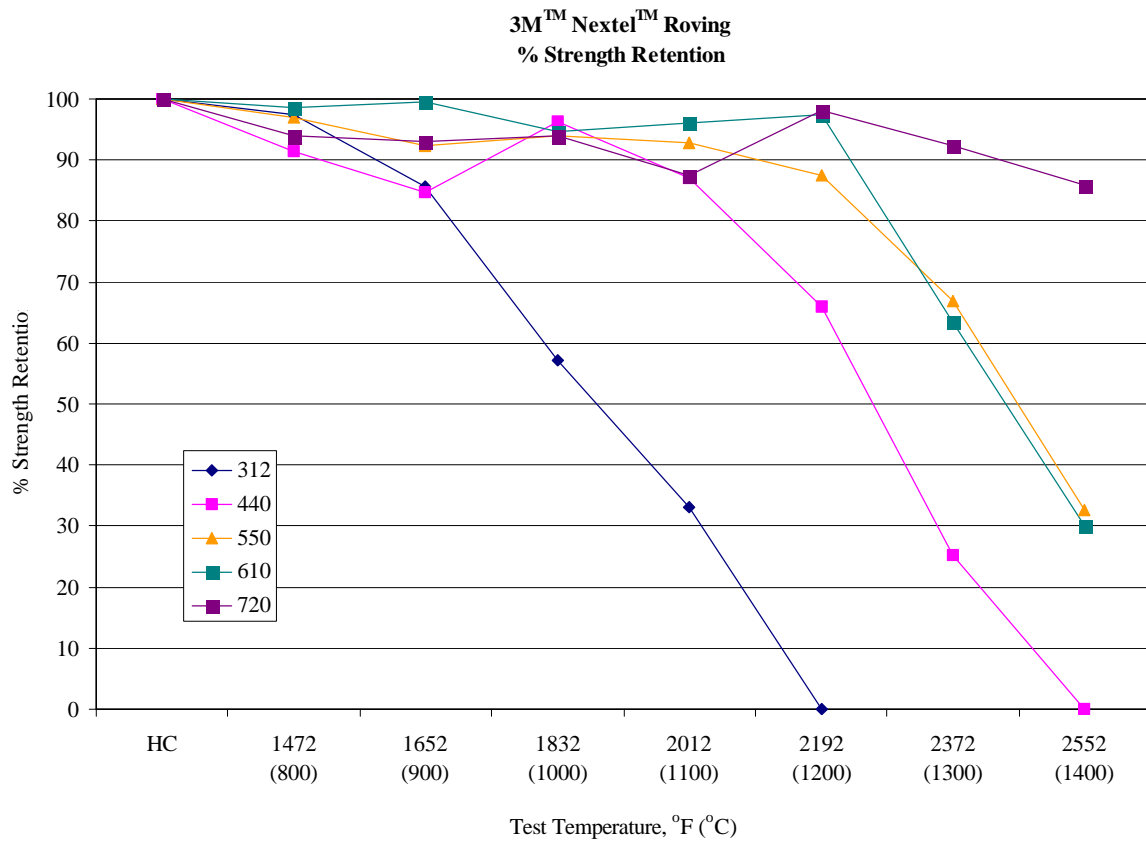
Sample Number: 5

Samples: Nextel Roving 312, 1800 denier & Nextel Roving 440 & 550, 2000 denier

Gage Length: 2 inches (5.1 cm)

Extension Rate: 0.5"/min (1.3 cm/min)

Note: All samples were heat cleaned (sizing removed) at 932°F (500°C) which represents the 100% strength bar. All the samples were wetted with DI water before testing to aid in handling.



Outline of Test:

Sample Number: 10

Samples: Nextel Roving, 1500 denier (400 filaments / bundle)

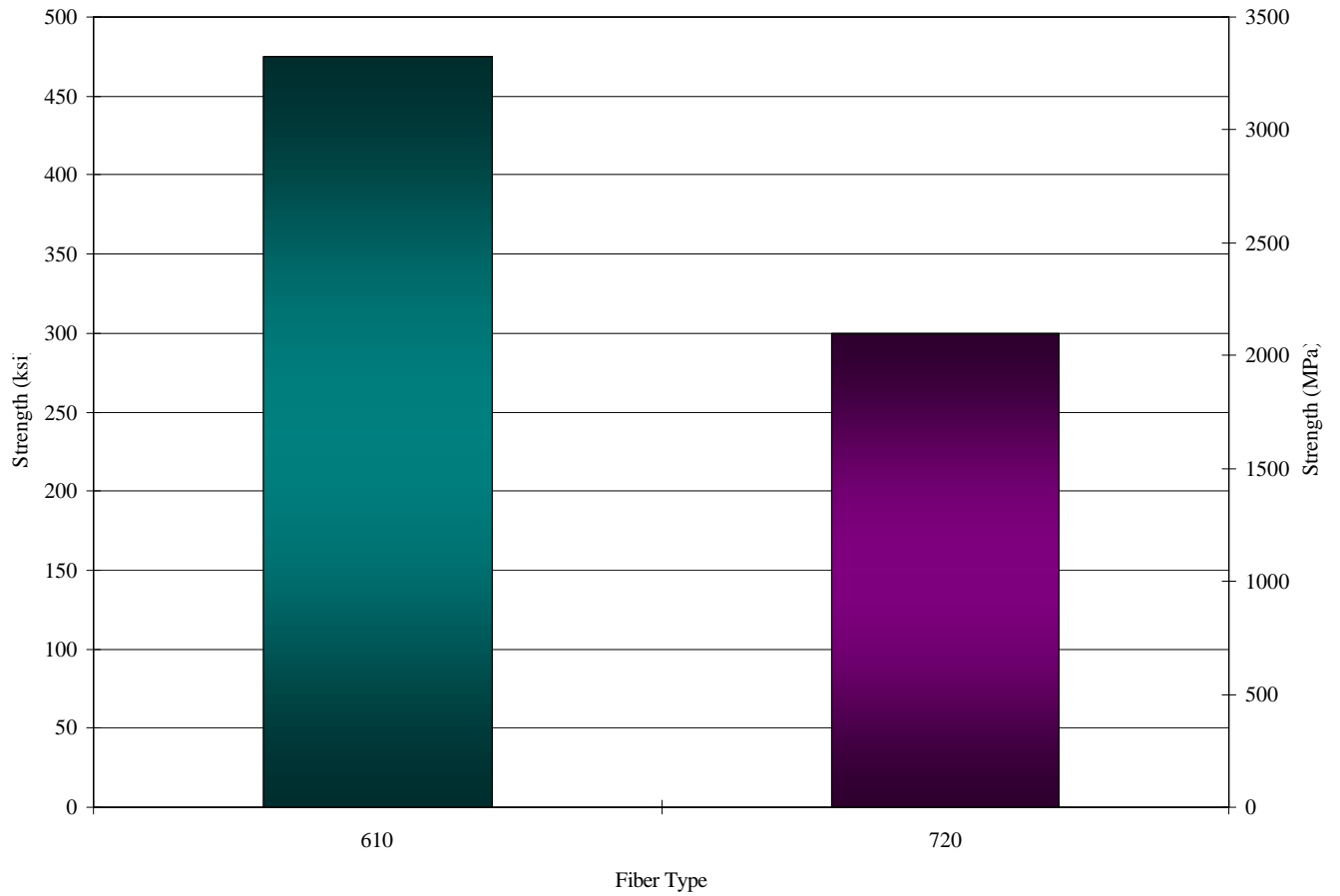
Total Gage Length: 10 inches (254 mm)

Hot Zone Length: 1 inch (25,4 mm)

Extension Rate: 0.5inch/min (12.7 mm/min)

Note: Samples were held at temperature for approximately 1.5 minutes before testing.

**3M™ Nextel™ Composite Fibers
Single Filament Strength**



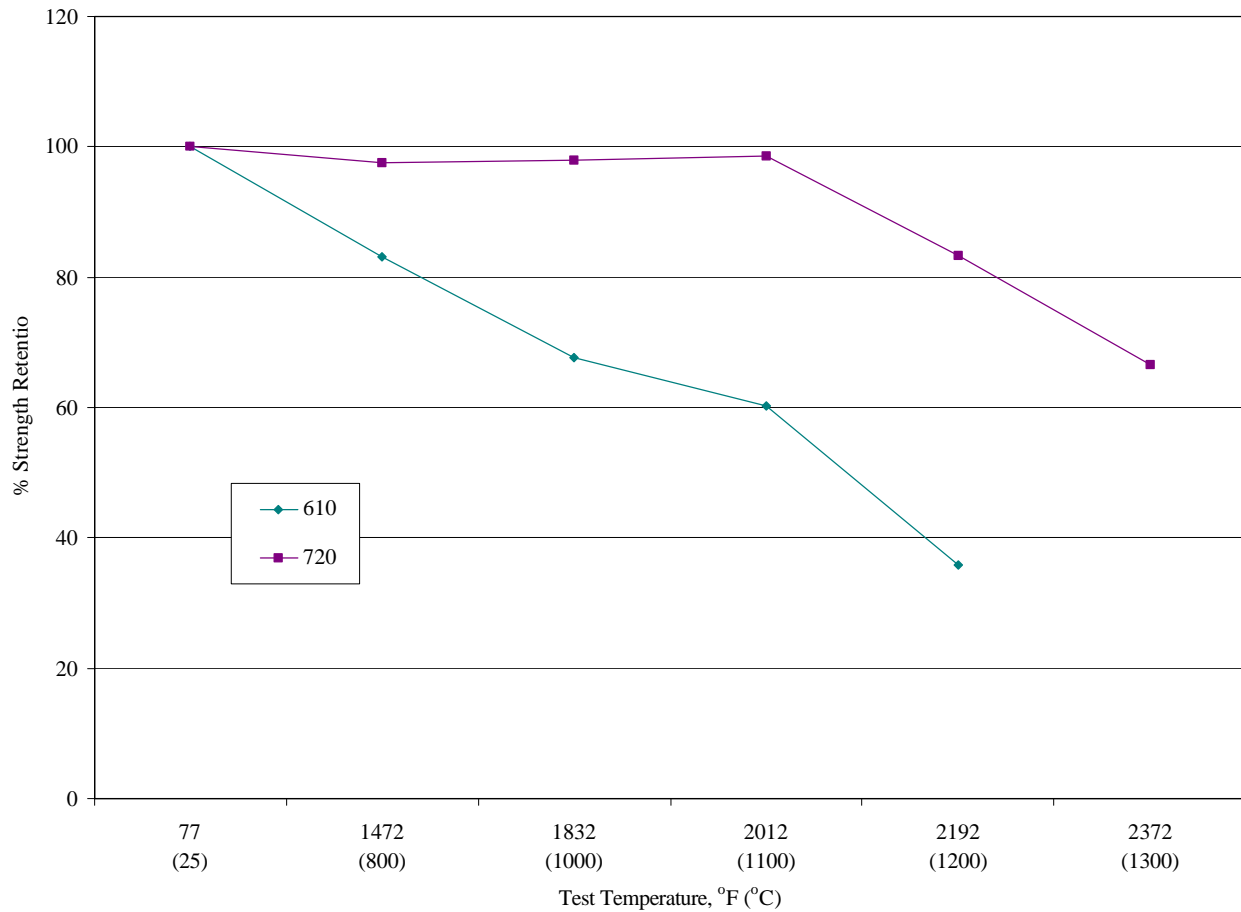
Outline of Test:

Sample Number: 10

Gage Length: 1 inch (25,4 mm)

Extension Rate: 0.2 inch/min (5.1 mm/min)

3M™ Nextel™ Composite Fibers
% Strength Retention At Temperature
(Single Filament)



Outline of Test:

Sample Number: 10

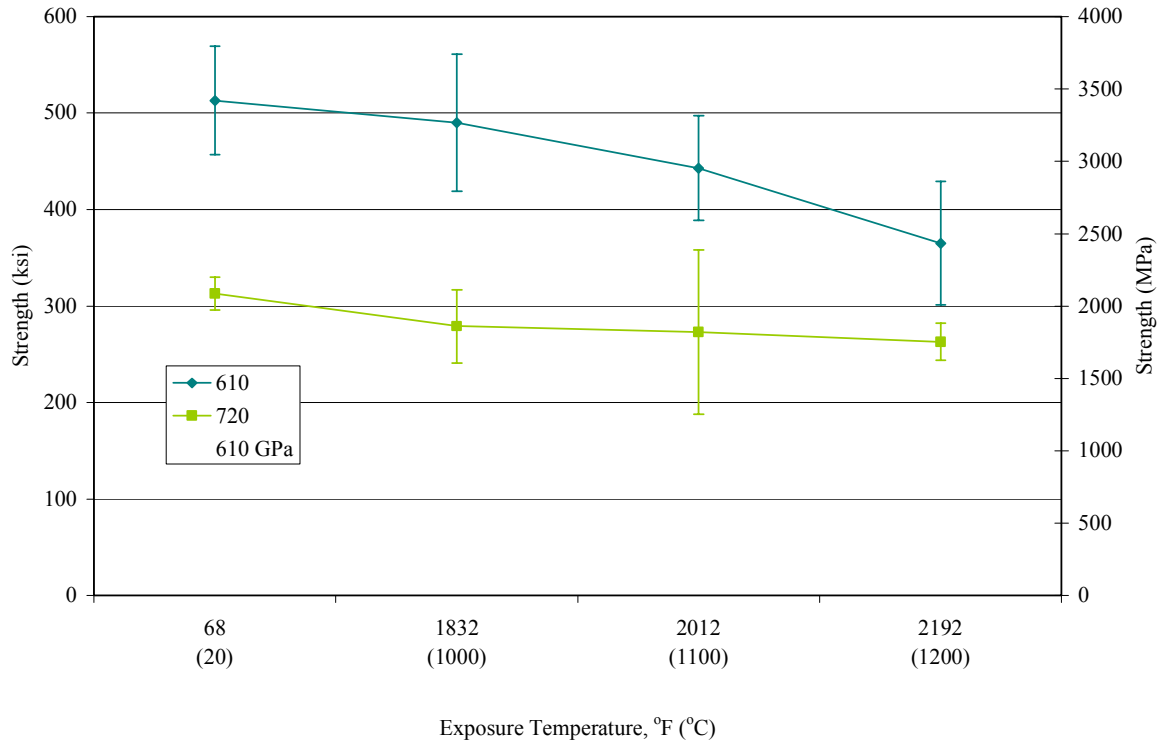
Total Gage Length: 10 inches (254 mm)

Crosshead Speed: 0.3 inches/min (0.76 mm/min)

Hot Zone Length: 1 inch (25,4 mm)

Note: Samples were held at temperature for approximately 1.5 minutes before testing.

**3M™ Nextel™ 610 & 720 Single Filament
Strength After 1000 Hour Exposure**

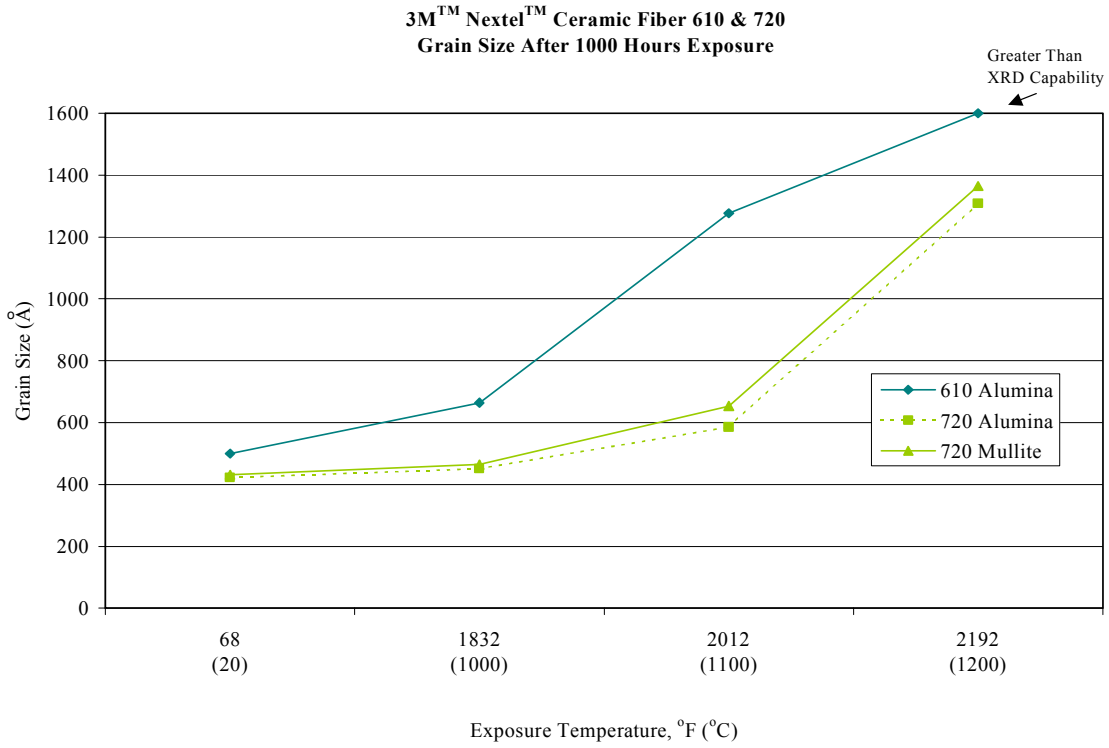


Outline of Test:

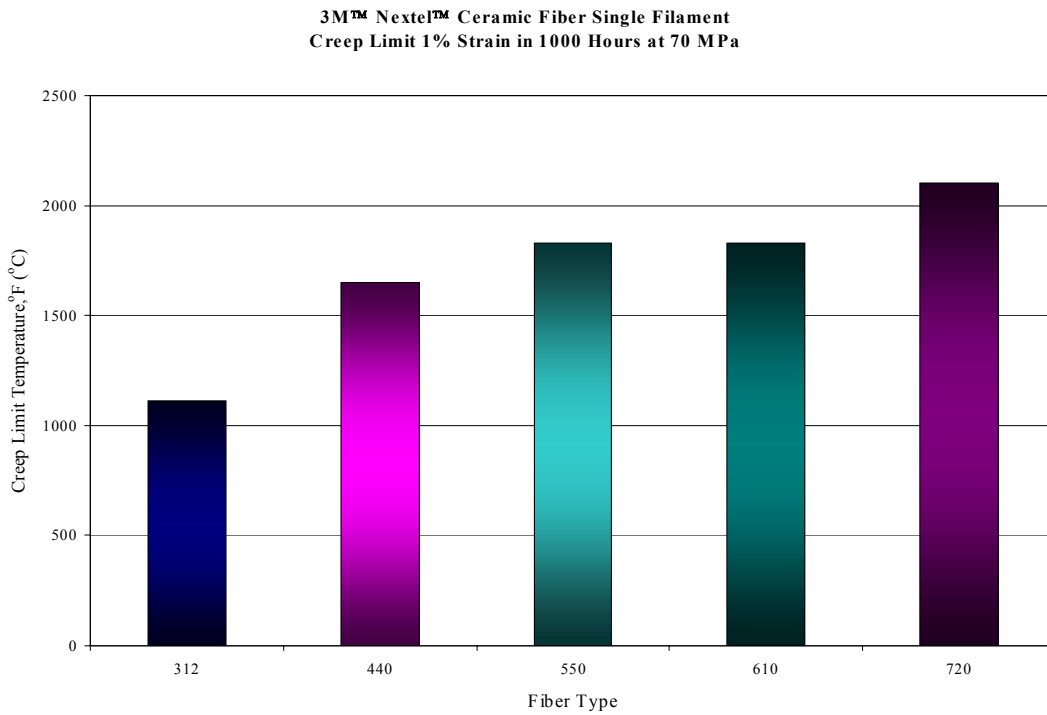
Sample Number: 10

Crosshead Speed: 0.02 inch/min (0.5 mm/min)

Gage Length: 1 inch (25,4 mm)



Grain size determined by X-ray diffraction.



Typical property data is for engineering use only. Contact a 3M representative before developing a specification. See Important Notice to Purchaser for details.