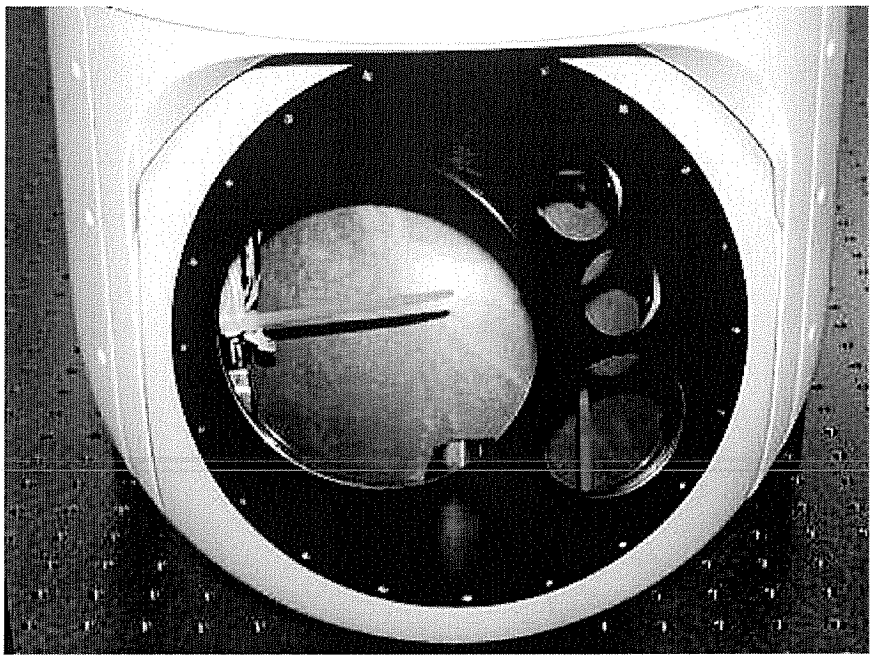


Figure 9: photograph of an ITT FALCON terminal with a window assembly with ALON® windows.

The FALCON terminal was used in a lasercom demonstration between two counter maneuvering aircraft, separated by distances as great as 132 Km, at data rates as high as 2.25 GB/sec.

Transparent Armor

Transparent ceramic materials such as ALON® Optical Ceramic, spinel and sapphire offer a quantum leap in ballistic performance over conventional glass laminates. Each of these materials has been shown to provide protection against armor piercing rounds at about one half the weight and thickness of conventional glass laminates. However, the relatively high cost (compared to glass) and availability of these materials are currently the largest obstacles to their wide spread use. While these materials will always be more expensive than glass, the ability to substantially decrease the cost and increase the production volume will determine if any of these materials will be viable towards transparent armor market. It is precisely in these areas that ALON® Optical Ceramic has an advantage over spinel and sapphire.

Comparison of ALON and Spinel for Transparent Armor

While Surmet produces both ALON and spinel, we market only ALON for transparent armor applications based upon cost and producibility advantages. While both ALON and spinel are produced by conventional powder processing techniques (Figure 7), and the processes for producing these two materials are very similar, ALON has several advantages over spinel in terms of producibility:

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- The process for ALON is more robust and mature, and less susceptible to lot to lot variations.
- Surmet produces its own ALON powder
  - at a significantly lower cost than that of spinel powder
  - without the lot to lot variation often seen in commercially available spinel powders
- The process yields for ALON are currently higher than for spinel

For these reasons we are able to produce larger lots of ALON® material at a consistently high quality, than are currently possible for spinel. These same factors make ALON a more affordable option than spinel.

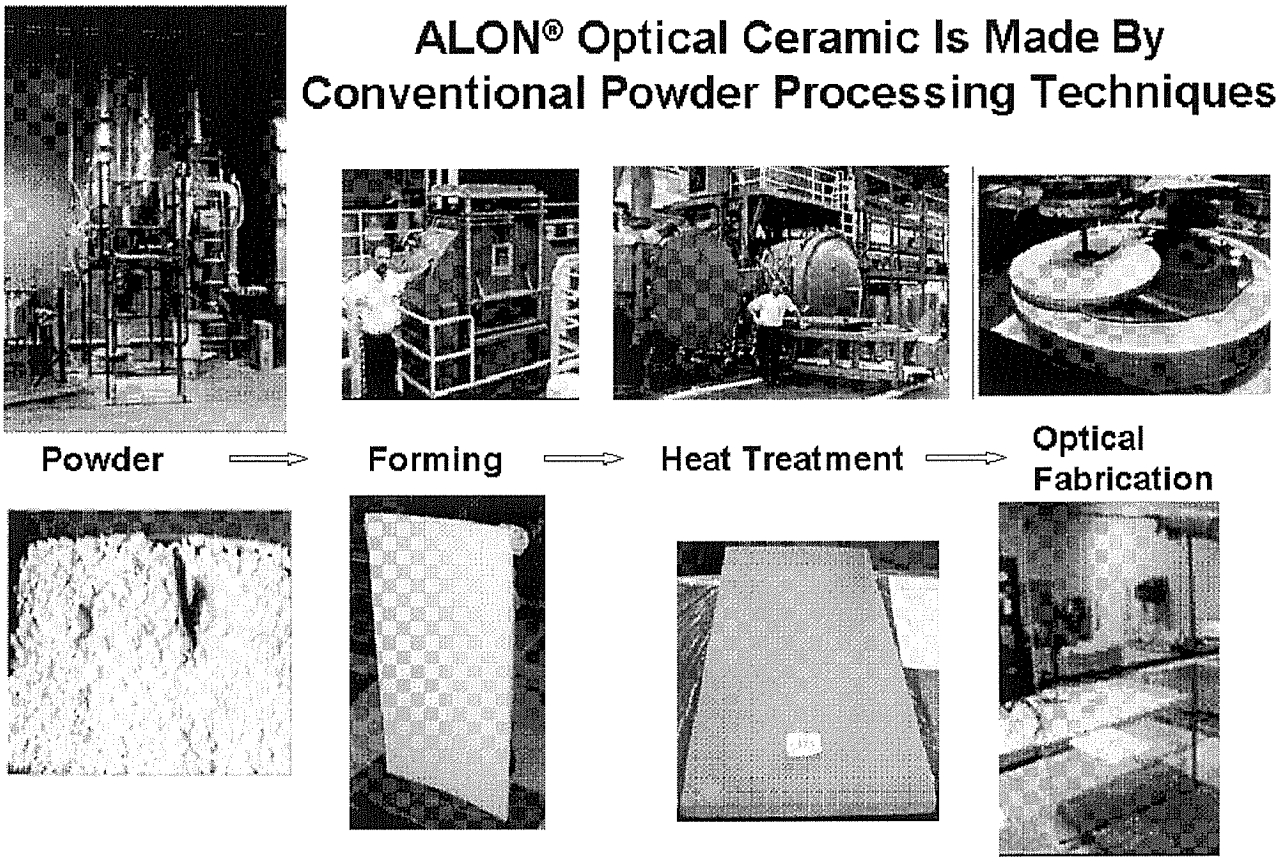


Figure 7: Schematic of process for producing ALON by powder processing

Comparison of ALON to Sapphire for Transparent Armor

While ALON is made by conventional powder processing techniques (Figure 7), sapphire is grown by melt based single crystal growth techniques. This limits the size (particularly thickness and width) that can be grown in reasonable cycle time and at affordable price. Furthermore, there is little economy of scale for single crystal growth techniques. If you want to double your capacity, you must double the number of crystal growers. By comparison, there is a considerable economy of scale for powder processing based

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production equipment. Dramatic improvements in throughput, and cost savings, can be attained through the use of larger furnaces.

ALON can easily and affordably be produced in thicknesses well above 0.3 in. (the currently supplied standard sapphire layer thickness). ALON® transparent armor thus holds an advantage particularly against armor piercing (AP) threats larger than 30 caliber round (12.7 mm, 14.5 mm, etc.) and against improvised explosive devices (IEDs). For threats larger than 30calAP, this sapphire layer thickness falls below the commonly used rule of thumb for hard faced armor. Thus, ALON® transparent armor is expected to provide a more efficient solution against larger AP and IED threats. While thicker sapphire layers can be produced, it is not likely that it can be done cost effectively, as thicker layers require much slower crystal growth rates.

Figure 8 below shows a photograph of an monolithic ALON window that is ~1.3-in thick.



Figure 8 photograph of 1.3-in thick ALON window from the front and side.

Results on 50 Cal AP Testing on ALON® Armor

Recently, we have concentrated much of our testing on higher level threats such as 50 cal AP threats. This is in large part due to the interests of our particular customer base, and in part to the recognition that it is easier to justify the relatively higher cost of ALON transparent armor for higher level threats where the benefits are more substantial.

While much of the testing that we have performed in the recent past is customer specific and consequently quite sensitive, and is some cases classified, one set of testing was performed specifically for, and shown on the Discovery Channel show 'How Stuff Works' (January 8th , 2009 episode). In this testing the performance of ALON transparent armor laminates was compared to the performance of conventional glass laminates. In particular, an ALON laminate nominally 1.6-in thick, with an areal density of ~19 psf was compared to a glass laminate nominally 3.6-in thick and with an areal density of approximately 43 psf. Both samples were shot with 50 cal M2AP rounds at the University of Dayton Research Institutes (UDRI) ballistic test range. High speed video (~5000 frames/sec) was taken of the impacts on these two types of laminates.

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A sequence of high speed images of the 50 cal M2AP rounds on the ALON® and glass laminates is shown below in figure 9.

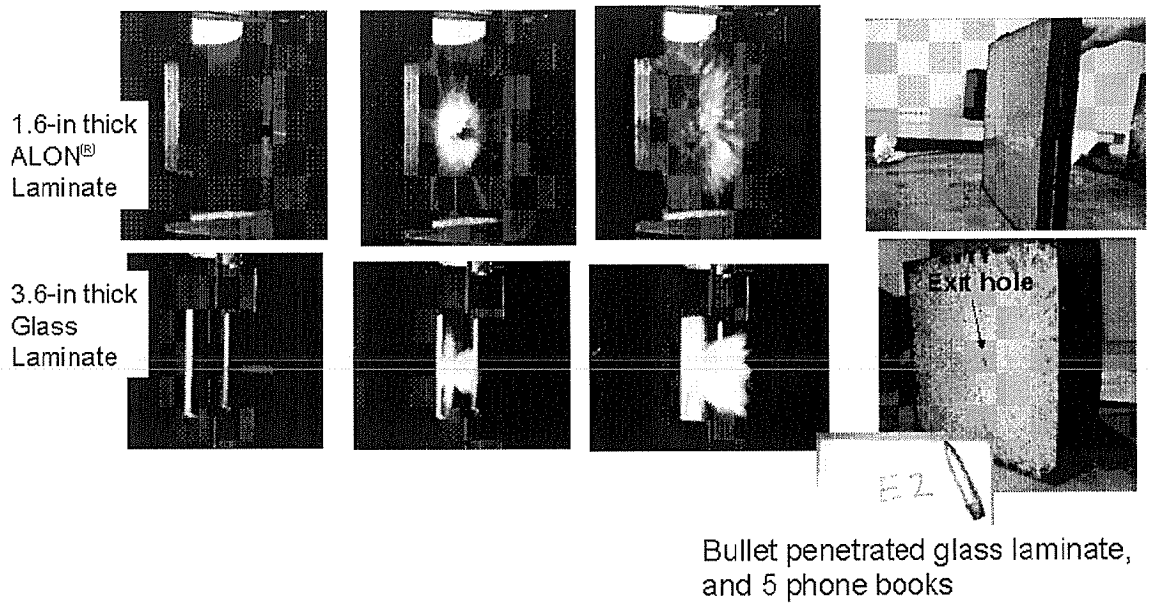


Figure 9: Sequence of high speed images of 50 cal M2AP round impacting 1.6-in thick ALON® laminate (top) and 3.6-in glass laminate (bottom). The laminates are also shown after impact, with the exit hole clearly visible in the glass laminate. Also shown in the bottom right is the bullet that penetrated the glass laminate.

ALON® armor is now in production for a few aerospace applications with small to medium quantities. One of these applications required that we obtain FAA certification. It is also being evaluated for a number of high volume transparent armor applications including Gunner Protection Kits (GPKs). Recently, ALON, spinel and sapphire were tested side by side by the Army for GPK windows. While all three materials met the minimum test requirements, the ALON windows demonstrated substantially higher V50 performance than either the spinel or sapphire windows.

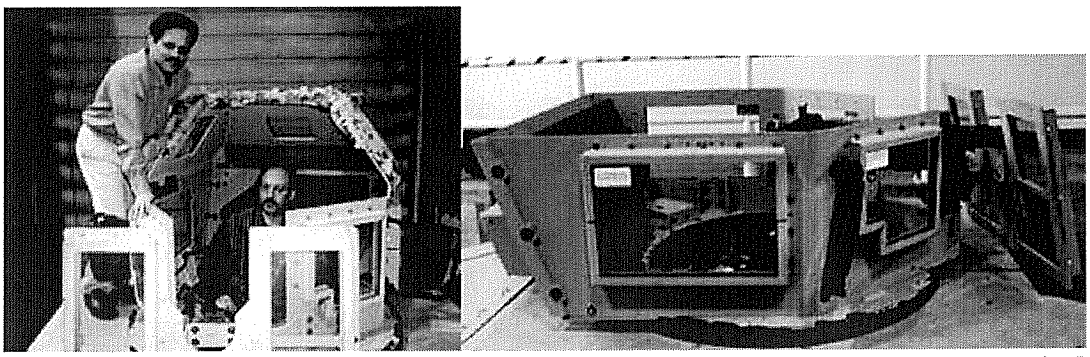


Figure 10: Photographs of gunner protection kits with transparent armor windows

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Surmet is continuing to work with Engineers at Picatinny Arsenal to insert ALON armor windows into GPKs for various armored vehicles.

Surmet has recently obtained security clearances for its HQ facility in Burlington, MA and key personnel working there. These clearances allow us to work closely with our customers on classified armor programs.

Summary

The demand for ALON® Optical Ceramic products continues to grow. Its excellent mechanical and optical properties combined with its producibility make it the material of choice for a number of military and commercial applications. These applications include: Recce windows, specialty domes, Lasercom windows and transparent armor. Investments continue to be made to expand our production capacity for ALON® Optical Ceramic.

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