Transient Liquid Phase Reactive Sintering of Aluminum Oxynitride

As a Department of Energy multi-program laboratory, the Idaho National Laboratory conducts a broad range of basic and applied research focusing on comprehensive survivability solutions. The latest advancement in survivability technology is a new procedure used to produce transparent aluminum oxynitride (ALON).

ALON ceramic offers the potential of ballistic protection with a commensurate weight savings compared to traditional glass or polymer-based transparent armor. ALON has been shown to repulse lethal-armor-piercing rounds at a fraction of the thickness and overall weight of glass or polymer laminates.

The ALON-soluble powder would be a liquid-promoting compound that would be sintered to eliminate residual porosity and produce optically transparent ALON without the hot isostatic pressing operation. A single high-temperature sintering operation is used to promote the formation of a transient liquid phase. The liquid phase enables the elemental powder particles to freely rearrange and rapidly consolidate, thereby eliminating porosity.

Benefits

The current production method used to create ALON is highly involved and complicated, resulting in low productivity, high costs, and manufacturing problems during scale-up. However, with the new production process ALON provided several benefits that were non-existent under previous manufacturing techniques.

ALON provides the following benefits over existing ALON fabrication techniques:

- Capable of forming into curved shapes and large continuous pieces (current processes allow for the production of pieces no larger than 16” x 32”)
- Cost effective manufacturing process (reduces time and energy expenditures)

ALON provides many benefits over traditional glass and polycarbonate armor. Some of the benefits include:

- Transparency on the electro-magnetic spectrum from ultraviolet rays to mid-wave inferred rays
- High strength and extreme hardness
- Excellent resistance to chemical etch
- Stable to high temperatures
- Cost effective manufacturing process

Application

Previously ALON has not found widespread application because of the difficulty and expense of fabricating large panels for such applications as windshields and windows. However, with the new production process there is strong commercial application for any type of bullet-resistant products such as, bank teller windows, guard booths, transparent armor, building windows, and point of sale scanner windows.

INL is working to improve the clarity of a pressureless sintered form of Aluminum Oxynitride (ALON), as a transparent armor, which would result in reduced production costs, while maintaining survivability levels of existing ALON products.

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