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Microstructure – Mechanical Strength Relationship of Aluminum Nitride

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Background

- Aluminum Nitride materials are used in the electronics industries as heat sinks due to their high thermal conductivity and electrically insulative properties.
- Mechanical integrity of these parts are of importance in high reliability applications (e.g. aerospace) to ensure electrical breakdown does not occur.
- Yttrium oxide is a common sintering aid for AlN. Quantity and processing conditions can have an effect on the resulting properties [1].

Objective

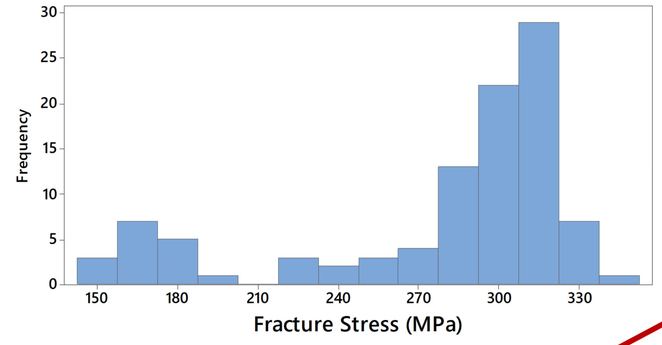
- Test mechanical reliability of material by measuring strength of many samples.
- Determine whether strength distributions is linked to microstructural differences.

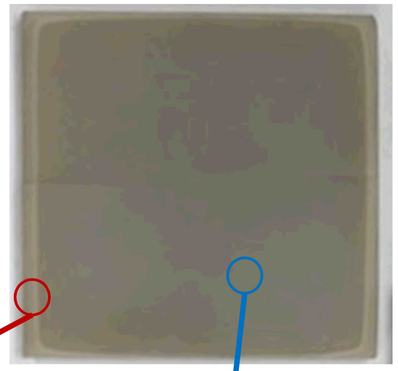
Approach

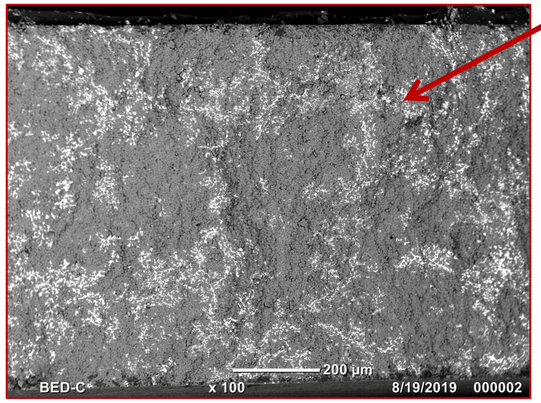
- Measure equibiaxial flexure strength of Sienna Technologies, Inc. ST-200 using a ring-on-ring flexure testing (ASTM C1499).
- Perform microstructural characterization with SEM on all specimens to correlate microstructure to strength distributions.

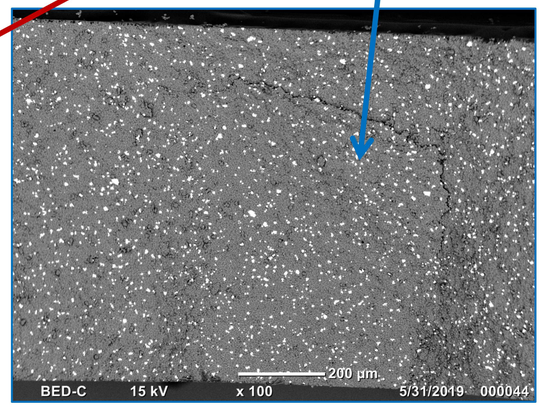
References

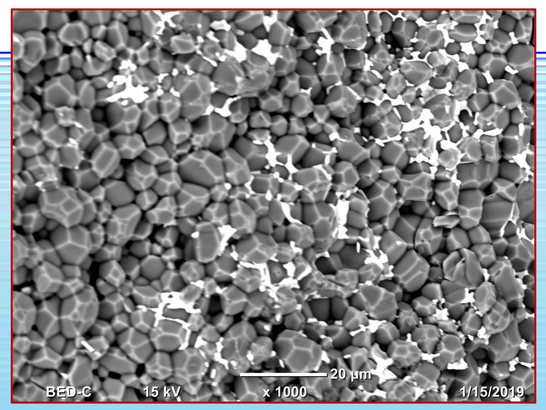
[1] P. S. de Baranda, A. Knudsen and E. Ruh, "Effect of Yttria on the Thermal Conductivity of Aluminum Nitride," Journal of the American Ceramic Society, vol. 77, no. 7, pp. 1846-1850, 1994.



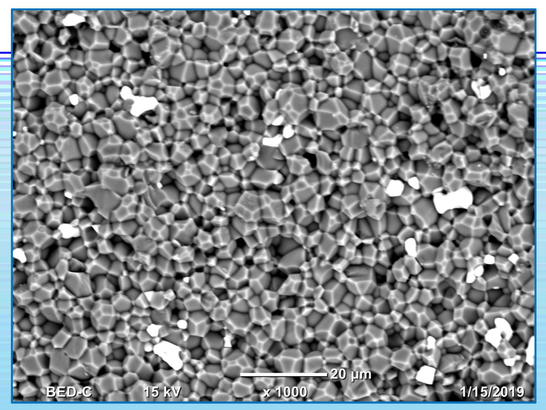




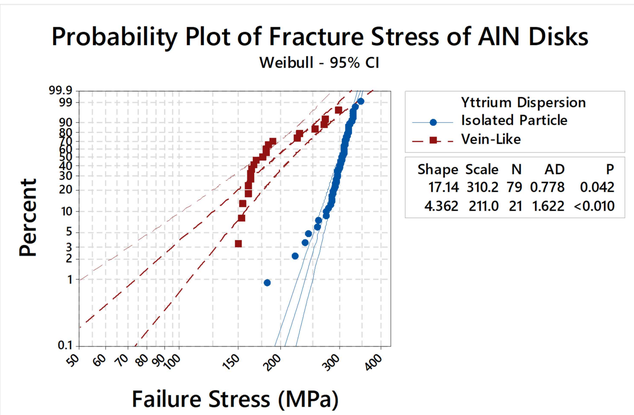




Vein-Like Yttria Dispersion



Isolated Particle Yttria Dispersion



Results

- Bimodal distribution of strength suggested two separate flaw populations.
- SEM correlates strength distributions with Yttria dispersion within the microstructure.
- The population with isolated particle yttria dispersion had:
  - A significantly higher average flexural strength (300 MPa vs 193 MPa),
  - Higher Weibull Modulus (17 vs. 4),
  - A better Weibull distribution fit.

Summary

- There was a skin of the vein-like yttria dispersion near the surface of the AlN billets as compared to isolated particles within the bulk.
- Different Yttria dispersions are likely due to thermal effects during processing.
- Future studies should investigate fracture origins in and causes of the different yttria dispersions.

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