

| Property                            | Units                 | C-TUFF™ Grade    |                |                  | Alumina<br>(99.5%) | Zirconia<br>(TZP) | Tungsten Carbide<br>(with 6% Co) |
|-------------------------------------|-----------------------|------------------|----------------|------------------|--------------------|-------------------|----------------------------------|
|                                     |                       | A4AS             | S7             | HA9S             |                    |                   |                                  |
| Density                             | g/cm <sup>3</sup>     | <b>3.87</b>      | <b>3.74</b>    | <b>3.72</b>      | 3.89               | 6.07              | 14.5                             |
| Flexural Strength<br>(4 pt bend)    | MPa                   | <b>450 - 500</b> | <b>500-550</b> | <b>550 - 700</b> | 380                | 1350              | 2400                             |
| Young's Modulus                     | GPa                   | <b>385</b>       | <b>390</b>     | <b>400</b>       | 360                | 205               | 610                              |
| Vickers Hardness                    | GPa                   | <b>18.3</b>      | <b>18.8</b>    | <b>20.7</b>      | 17.0               | 13.5              | 20                               |
| Fracture Toughness<br>(Indentation) | MPa·m <sup>1/2</sup>  | <b>4.5 - 5</b>   | <b>6.5 - 7</b> | <b>7 - 9</b>     | 4.0                | 8.5               | 15                               |
| Thermal Conductivity                | W / m·K               | <b>26</b>        | <b>31</b>      | <b>35</b>        | 25                 | 2.2               | 94                               |
| Coefficient of Thermal<br>Expansion | 10 <sup>-6</sup> / °C | <b>7.2</b>       | <b>7.0</b>     | <b>6.8</b>       | 7.6                | 10.0              | 5.0                              |
| Thermal Shock<br>Resistance (ΔT)    | °C                    | <b>400</b>       | <b>700</b>     | <b>1000</b>      | 200                | 350               | -                                |
| Impact Resistance                   | -                     | Fair             | Good           | Excellent        | Poor               | Poor              | Fair                             |