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## Niobium (Columbium)

**Niobium**, or **columbium**, is the chemical element with the symbol **Nb** and the atomic number 41. A rare, soft, grey, ductile transition metal, niobium is found in the minerals pyrochlore, the main commercial source for niobium, and columbite.

Applications of niobium include its use in welding, nuclear industries, electronics, optics, numismatics and jewelry. In the last two applications, niobium's low toxicity and ability to be colored by anodizing are particular advantages. Niobium and some niobium alloys are used in medical devices such as pacemakers, because they are physiologically inert (and thus hypoallergenic). Niobium treated with sodium hydroxide forms a porous layer that aids osseointegration. Along with titanium, tantalum, and aluminum, niobium can also be electrically heated and anodized, resulting in a wide array of colors using a process known as reactive metal anodizing which is useful in making jewelry.

| <b>Physical Properties</b>                | Metric   | English  | Comments |
|---|--|--|----------|
| Density                                   | <u>8.60 g/cc</u>   | <u>0.311 lb/in<sup>3</sup></u>                               |          |
| Molecular Weight                          | <u>92.906 g/mol</u>  | <u>92.906 g/mol</u>  |          |
| <b>Mechanical Properties</b>              | Metric   | English  | Comments |
| Hardness, Vickers                         | 80   | 80   |          |
| Tensile Strength, Ultimate                | <u>300 MPa</u>   | <u>43500 psi</u>   |          |
| Tensile Strength, Yield                   | <u>207 MPa</u>   | <u>30000 psi</u>   |          |
| Elongation at Break                       | 30.00%   | 30.00%   |          |
| Modulus of Elasticity                     | <u>103 GPa</u>   | <u>14900 ksi</u>   |          |
| Poissons Ratio                            | 0.38   | 0.38   |          |
| Shear Modulus                             | <u>37.5 GPa</u>  | <u>5440 ksi</u>  |          |
| <b>Electrical Properties</b>              | Metric   | English  | Comments |
| Electrical Resistivity                    | <u>0.0000151 ohm-cm</u>                                    | <u>0.0000151 ohm-cm</u>                                      |          |
| Magnetic Susceptibility                   | 0.00000228   | 0.00000228   | cgs/g    |
| Critical Magnetic Field Strength, Oersted | 2010 - 2110  | 2010 - 2110  |          |
| Critical Superconducting Temperature      | 9.23 - 9.27 K  | 9.23 - 9.27 K  |          |
| <b>Thermal Properties</b>                 | Metric   | English  | Comments |
| Heat of Fusion                            | <u>290 J/g</u>   | <u>125 BTU/lb</u>  |          |
| CTE, linear                               | <u>7.10 <math>\mu\text{m}/\text{m}\cdot\text{C}</math></u> | <u>3.94 <math>\mu\text{in}/\text{in}\cdot\text{F}</math></u> |          |
|   | @Temperature 20.0 - 100 °C                                 | @Temperature 68.0 - 212 °F                                   |          |
|   | <u>7.38 <math>\mu\text{m}/\text{m}\cdot\text{C}</math></u> | <u>4.10 <math>\mu\text{in}/\text{in}\cdot\text{F}</math></u> |          |
|   | @Temperature 300 °C  | @Temperature 572 °F  |          |
|   | <u>7.61 <math>\mu\text{m}/\text{m}\cdot\text{C}</math></u> | <u>4.23 <math>\mu\text{in}/\text{in}\cdot\text{F}</math></u> |          |
| @Temperature 500 °C                       | @Temperature 932 °F  |  |          |
|   | <u>8.52 <math>\mu\text{m}/\text{m}\cdot\text{C}</math></u> | <u>4.73 <math>\mu\text{in}/\text{in}\cdot\text{F}</math></u> |          |
| @Temperature 1000 °C                      | @Temperature 1830 °F                                       |  |          |
| Specific Heat Capacity                    | <u>0.272 J/g·°C</u>  | <u>0.0650 BTU/lb·°F</u>                                      |          |
|   | <u>0.32506 J/g·°C</u>                                      | <u>0.077691 BTU/lb·°F</u>                                    | Gas      |
| Thermal Conductivity                      | <u>52.3 W/m-K</u>  | <u>363 BTU-in/hr-ft<sup>2</sup>·°F</u>                       |          |
| Melting Point                             | <u>2468 °C</u>   | <u>4474 °F</u>   |          |
| Boiling Point                             | <u>4744 °C</u>   | <u>8571 °F</u>   |          |
| Heat of Formation                         | <u>0.000 kJ/mol</u>  | <u>0.000 kJ/mol</u>  | Crystal  |
|   | <u>725.9 kJ/mol</u>  | <u>725.9 kJ/mol</u>  | Gas      |