# Selecting Wire Guides

By C. Kuan - 1995. Revised 2012

**Summery**

Hardness and Toughness should be considered hand in hand when selecting ultra hard materials for wire guides.

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One of the criteria in selecting wire guides is the **Hardness Value.** Ultra hard materials such as high alumina and tungsten carbide are preferred over plastics or steel. Figure 1 shows the Vickers Hardness and Fracture Toughness of the ultra hard materials used for wire guides.

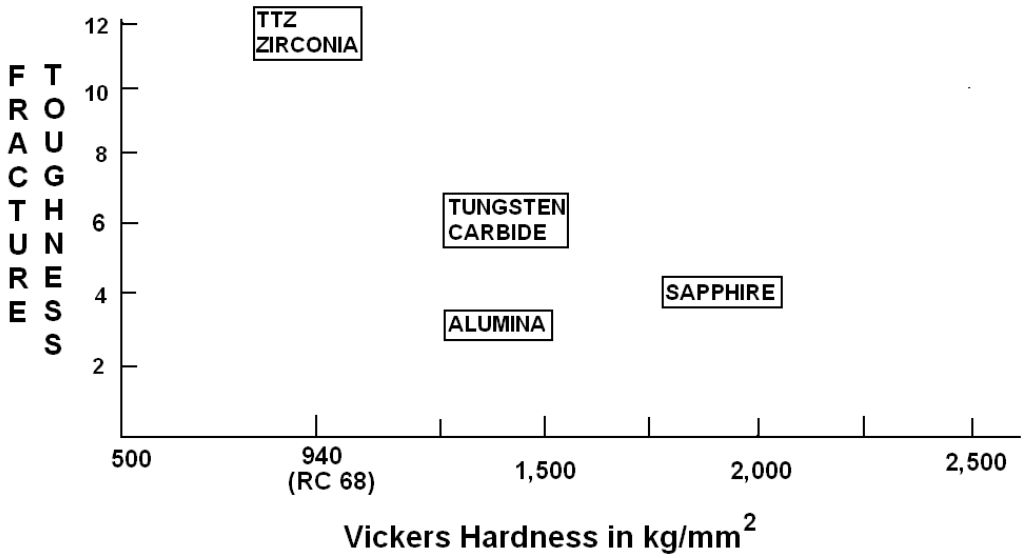


Figure 1 Toughness against Hardness Diagram

Another criterion in selecting wire guides is the **Surface Finish**, to which the guide's coefficient of friction against the wire is attributed. Scientific means are employed to ascertain the surface finish in unequivocal numbers; one such method is the use of the Diamond Probe Profilometer, an instrument which gives readings in microns or micro inches. (One micron is equal to 40 micro inches.) A lower profilometer reading generally indicates a smoother surface finish. An interesting yet little known fact is that higher hardness value is always associated with a finer surface finish, while mono-crystalline (that

is, a single crystal) materials like ruby and sapphire can be diamond polished to a lower profilometer reading compared with polycrystalline materials of equal hardness.

**Fracture Toughness**, a measure of a material's resistance to the propagation of a crack in the material, has in recent years been involved increasingly in the interpretation of wear phenomena. Figure 1 illustrates that Tetragonal Zirconia Polycrystal (TZP), also known as Transformation Toughened Zirconia (TTZ) and Tungsten Carbide offer higher fracture toughness compared with sapphire and alumina.

Over the years, extensive wear tests have been performed on the ultra hard materials which we choose for wire guides. Synthetic sapphire originating from one single source* and of the same lot is selected as the control to undergo an identical set of testing parameters. By dividing the unit weight loss of the material under test by that of the synthetic sapphire, a Relative Wear Rate (RWR) is obtained. The relative wear rates registered to date are tabulated in Figure 2:

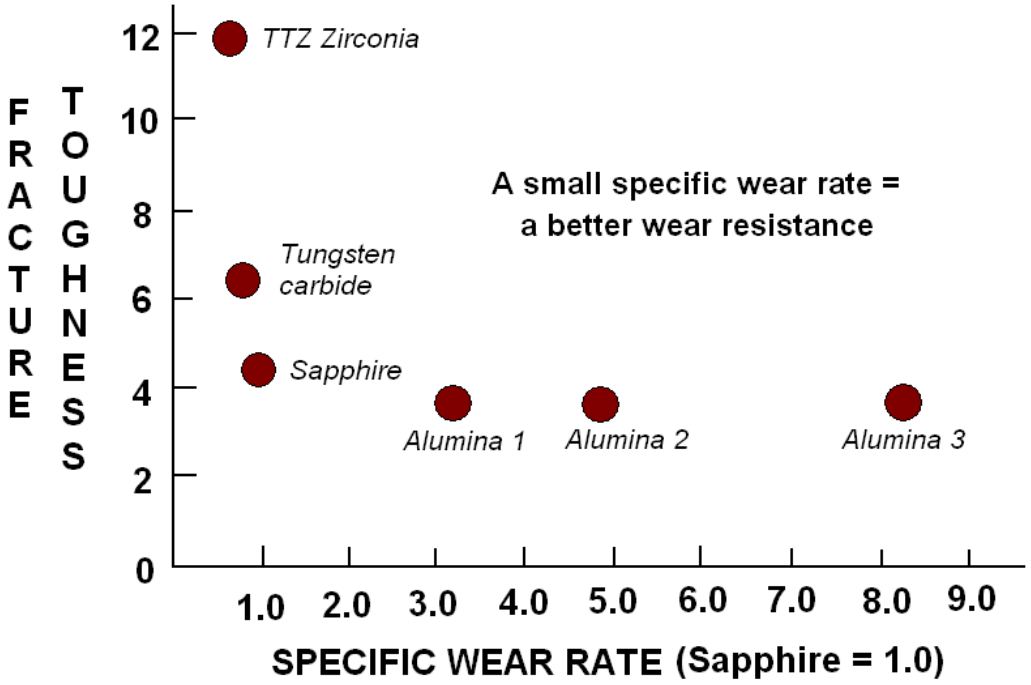


Figure 2 Toughness against Wear Rate Diagram

Results of the tests reveal that TZP or TTZ Zirconia, being of inferior hardness but higher fracture toughness, outwears synthetic sapphire. Performing less satisfactorily was all polycrystalline alumina of inferior hardness and fracture toughness. The spread in wear resistance among the three alumina materials is attributed to several factors: the percentage of the alumina content; the compacting pressure of the green body; and the mesh distribution of the powder. Based on the above test results, it can be postulated at this writing that Hardness and Toughness should be considered hand in hand when selecting ultra hard materials for wire guides.

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