gen during welding and a relatively large capital investment is needed to make a high quality titanium frame. The major technical problem with a titanium frame is its relatively low Young's modulus, which can result in a frame with excessive flex, particularly with a strong rider.

The chief advantage of aluminum is its low cost. However, aluminum also has a low Young's modulus and low tensile yield strength. In a crash the low yield strength and the lack of a cost effective repair capability for aluminum often means the destruction of the frame. Low strength also means relatively poor fatigue resistance.

Graphite is the material that is used to make the most aerodynamic bicycle frames. The free-form design capability is the major advantage of graphite and also a disadvantage since special molds are needed which can drive costs well above titanium. Graphite bikes are subject to hidden damage in a crash due to delamination on the I.D. surface. Even a scratch can lead to tube failure. Graphite must be connected to something else and the coupling of graphite to metals can lead to galvanic corrosion. Although many advances have been made, fabrication with glues is more risky than brazing or welding.

Building a bicycle out of metal-matrix composite tubes sounds like high technology, but the results are not entirely satisfactory. The matrix is aluminum and the additive is usually a refractory-type particulate such as Al_2O_3 or B_4C. The metallurgical challenge is to bond the Al_2O_3 or B_4C to the aluminum matrix in such a way that TIG welding will make an acceptable bond. Metal-matrix composite bicycles can also be fabricated by gluing into special lugs. The aluminum matrix has a low modulus and the bike tubes must use the same special geometry used for aluminum. Crash worthiness is unknown.

AerMet 100 alloy has a very high strength-to-weight ratio, fatigue resistance exceeding that of Ti-3Al-2.5V alloy, is less costly than Ti-3Al-2.5V alloy, can be fabricated using brazing and TIG-welding, has corrosion resistance better than that of AISI 4130 steel, and because of its very high yield strength is very crash-worthy. Bike frames have been successfully fabricated from AerMet 100 alloy and have been well received by top American riders.