AerMet® 100 Alloy for Bicycles

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Most people would agree that the technology used by the military/aerospace industry is "state-of-the-art". But that industry certainly is not the only one in which marketing success involves state-of-the-art technology. Another area where the latest in materials technology can be seen is at a bicycle race. There, materials such as steel, aluminum, titanium, metal-matrix composite, graphite and kevlar are likely to be represented.

One of the target markets for AerMet® 100 alloy has been bicycle tubing. It is in bicycles, possibly more than aerospace applications, that AerMet 100 alloy must compete with advanced materials. For the F/A-18 E/F aircraft landing gear the competition was high strength material like 300M alloy. In bicycles the competition is primarily titanium, followed by other steels, then graphite, metal-matrix composites and finally aluminum.

There is more to building a bicycle than simply using a high-strength material. The builders have to be able to fabricate it into a frame. In addition to the weight of the frame, the riders have to like the "feel" of the frame. And if there is a crash, the frame must survive. Finally, there is the cost of the frame to be considered. A comparison of the major competitive materials is shown in Table VIII.

The table shows the advantages and disadvantages of the 6 major bicycle tube materials. The steel alloy typically used for bicycle tubes is AISI 4130. Many bike frames are made from tubes that have not been heat treated and have a yield strength of ~100 ksi. These tubes generally have a wall thickness of 0.030 inches (0.7 mm) and provide a frame weight of about 5 pounds. Tube sets cost $50 to $100.

Steel can also be heat treated or cold worked to increase strength. In this category the yield strength is ~130 ksi, wall thickness is 0.025 inches (0.6mm) and frame weight approximately 4 pounds. The cost of these tube sets is $100-$250. As the wall thickness decreases below 0.025 inches (0.6 mm), fatigue, corrosion and denting become concerns. Steel's major advantages are cost, availability, and ease of fabrication, i.e., it can be readily brazed or TIG welded.

The titanium alloy used is Ti-3Al-2.5V and the initial frames were made from aerospace tubing. The weight of a titanium tube set is about 3.5 pounds. The corrosion and fatigue problems of thin wall steel frames are solved by using titanium; however, the cost of titanium tubes ($25 per foot), is a major drawback as is the fabricability. Titanium combines readily with oxy-

Table VIII. Materials that have been used in bicycle framing components.

		Advantages	Disadvantages
AerMet® 100		**Fatigue/Wt., Strength/Wt., Fabrication, Moderate Cost**	**Practical Limit to Tube Wall Thickness, Corrosion**
Steel (4130)	Annealed	Cost, Fabrication	Crashworthiness, Weight
	Q & T	Cost, Fabrication, Weight	Fatigue/Corrosion
Titanium	Ti-3Al-2.5V	Fatigue/Wt., Strength/Wt., Corrosion Resistance	Cost, Fabrication, Young's Modulus
Aluminum	6061-T6	Cost, Weight	Crashworthiness, Fatigue, Young's Modulus
Graphite		Free-Form Design, Weight, Strength	Crashworthiness, Cost, Fabrication, Galvanic Corrosion
Metal Matrix Composite	Al+SiC $Al+B_4C$ $Al+Al_2O_3$	Strength/Wt.	Young's Modulus, Fabrication