SCANDIUM

There's been a lot of buzz in recent months about the introduction of Scandium enhanced alloys for bicycle tubing. How much is truth? How much is fiction?

Easton introduced Scandium enhanced alloys in 1998. Since that time, Easton's Sc7000 Scandium alloy has been recognized by the industry and bicycle enthusiasts around the world as the premier tubing for bicycle frames. Sc7000 frames have been ridden to victory in some of the world's most grueling races by some of the top professional teams in Europe and the USA. In last year's Paris-Roubaix race, the top three finishers, Knaven, Museeuw, and Vainsteins of the Domo-Farm Frites team *all rode Easton Sc7000 Scandium frames*. In the 2002 Paris-Roubaix, Easton's Sc7000 frame was again ridden to victory as Museeuw climbed one step higher on the podium.

What is your Scandium IQ?
Let's start with a quick quiz to see how much you know about Scandium.

TRUE OR FALSE?

- Scandium is the eighth most abundant rare earth element?
- Scandium is more abundant in the sun than on earth?
- Scandium appears on the periodic chart of elements as number 21?
- Scandium was discovered in 1879 by Lars Nilson?
- The Russian MIG-29 is made of Scandium alloy?

"In last year's Paris-Roubaix race, the top three finishers were on the Domo-Farm Frites team."

- Scandium is very difficult to extract from ore?
- It took four years for Easton to develop and test its Sc7000 alloy?
- Adding Scandium to an aluminum alloy makes the alloy stronger?

Answers: All true *except* for the last question. So what's the advantage of Scandium? Read on.

The Myth of Scandium
To understand the benefits let's first talk about what Scandium doesn't do. Scandium does not make an alloy stronger. If Scandium doesn't make an alloy stronger then what's all the noise?

The Reality of Aluminum
To understand the benefits of Scandium, it is important to understand what makes an alloy suitable for building a frame. First and foremost the alloy must be able to withstand the heat of welding. In reality there are only a few aluminum alloys that are actually weldable. Most 6000 series and some 7000 alloys can withstand the rigors of the torch. You might be surprised to learn that these are relatively *low strength* aluminum alloys. Their yield strengths are in the 35 to 42 ksi range.

The low strength of these alloys means that tube geometry is all important in controlling the strength and stiffness of the frame. This necessitates the use of larger diameter tubes. Larger diameter tubes translate into a stiffer, usually less desireable ride.

When you think about the different materials typically used in bicycle frames—steel, titanium and aluminum—the diameters vary widely. Steel having the highest strength properties (upwards of 150 ksi) allows the smallest diameter tubing to be used. Aluminum with its typical lower strength (35 to 42 ksi) generally requires the largest diameter tubing. Titanium (in the 85 ksi range) falls somewhere in between.

So what would happen if you made an aluminum frame

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with small diameter tubes in an attempt to gain a more compliant ride? Well, if all you had to work with was 35 to 42 ksi strength tubes (6000 and 7000 series alloys), the result would be a very flexible, whippy frame with a short life span.

Smaller diameter tubing *does* offer many advantages including ride comfort and weight reduction. This is attributable to the reduced material and greater compliancy of the smaller diameter tubes. Unfortunately traditional aluminum alloys are simply not strong enough to make smaller diameter tubes practical. Without adequate strength, fatigue life drops like a rock.

Easton's goal in developing Scandium-enhanced alloys was to make smaller diameter aluminum-alloy tubes practical for the first time ever. To create tube sets that combine the traditional advantages of aluminum's light weight with the compliant, responsive ride of steel—all without sacrificing strength or durability.

Exception to the Rule

Have you heard the saying that for every rule there is an exception? Well get ready for the exception. Earlier we made a statement that weldable alloys were generally low in strength. However, during the cold war the Russians figured out how to weld fins to sub-launched missiles that were strong enough to cut through polar ice caps. The same technology was used in their MiG fighters.

Their secret? You guessed it. They had developed high-strength weldable alumimum alloys using Scandium.

A Quest to Innovate

As a sporting goods company known for pushing the envelope of performance in its aluminum products, Easton is always looking for superior, new materials and cutting edge technology. Easton is well known for it's TaperWall cold-working process. (See R&D Q&A Number One—April 2002 issue). Cold working refines the grain and reduces the size of the boundary between the grains. Smaller grain size offers better toughness and fatigue life for tubing.

Scandium is also a potent grain refiner when added to a base alloy in the proper amounts. The combination of Scandium and Easton's extensive cold working signifigantly reduces grain size.

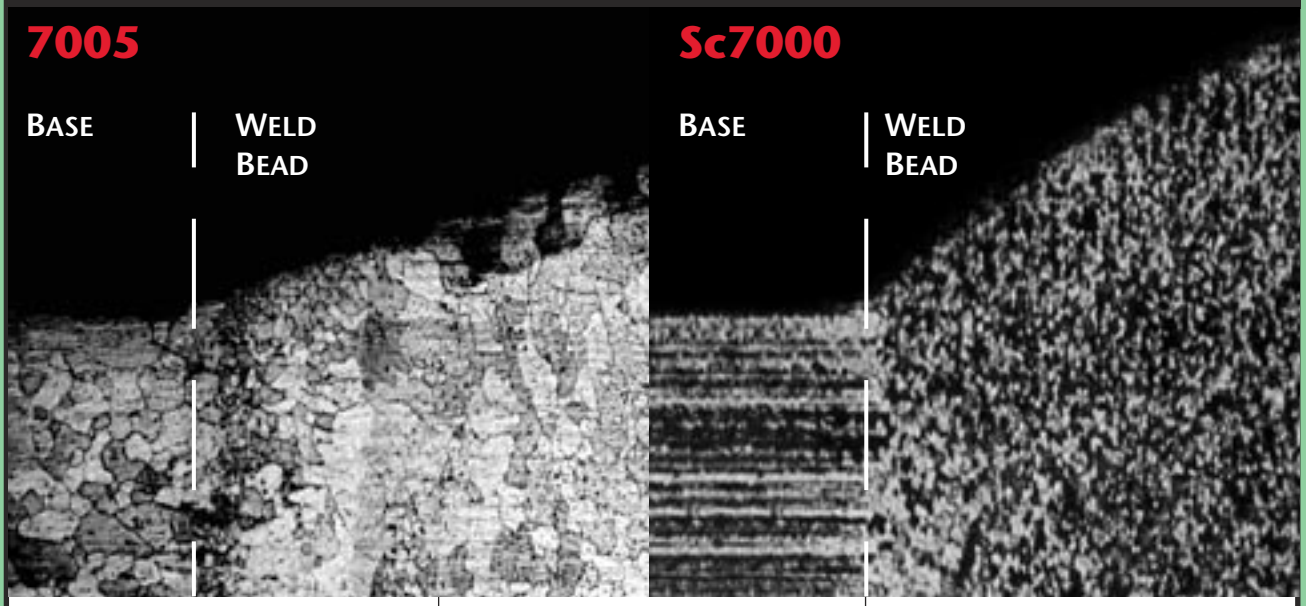
So if Scandium is added to the traditional aluminum alloys used in bicycle frames, would there be a signifigant increase in performance? Some, but not enough to justify the added expense.

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Eddy Merckx chose Easton Sc7000 Scandium for his frames ridden by the Domo-Farm Frites team. Domo riders placed one, two and three in the Paris-Roubaix race.

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Recrystallization of 7005 aluminum after welding leaves enlarged grain susceptible to cracking.

Scandium's smaller, more uniform grain resists heat-induced grain growth after welding.

Scandium for Scandium's Sake

While it is tempting to just take a traditional alloy and add Scandium to the alloy to further refine the grain, this would simply result in a more expensive alloy. This addition would not signifigantly enhance the tubings strength or weight characteristics. Remember, *Scandium does not add strength*. Without higher strength it would be detrimental to change the tube geometry. Keep in mind that Easton's goal was to develop a new frame tube set that offered the light weight of aluminum and the comfort of steel.

Where Scandium Shines

The critical advantage that Easton's proprietary Scandium alloys (Sc7000) bring to the party is the ability to minimize recrystallization after welding (see photos). Heat causes the grain size of aluminum to increase. Scandium helps to control this. Smaller grains mean smaller grain boundaries which in turn helps keep cracks from forming at weld joints.

Starting with a Stronger Alloy

Other manufacturers are beginning to offer their versions of Scandium alloy frame tubes.

"Adding Scandium to a standard low strength alloy like 7005 or 6061, as some manufacturers do, is an expensive waste of a high-tech material."

Simply adding Scandium to existing alloys is an expensive marketing ploy.

Easton wasn't content to start with typical 6000 or 7000 series alloys. Instead, Easton's R&D department started with a proprietary alloy that had been in development for four years. With its unique chemistry this alloy exhibited exceptional strength — 68 ksi. With the addition of Scandium, the new alloy's weldability was dramatically enhanced. Sc7000 was born.

Finally Easton had realized the potential of Scandium. Higher strength combined with the lower density of aluminum allowed for lighter, smaller diameter tubing. Better compliancy was realized without sacrificing fatigue life.

Lighter, more lively frames. Less harshness and better feel. Easton's Sc7000 has now become the choice of cyclists worldwide.