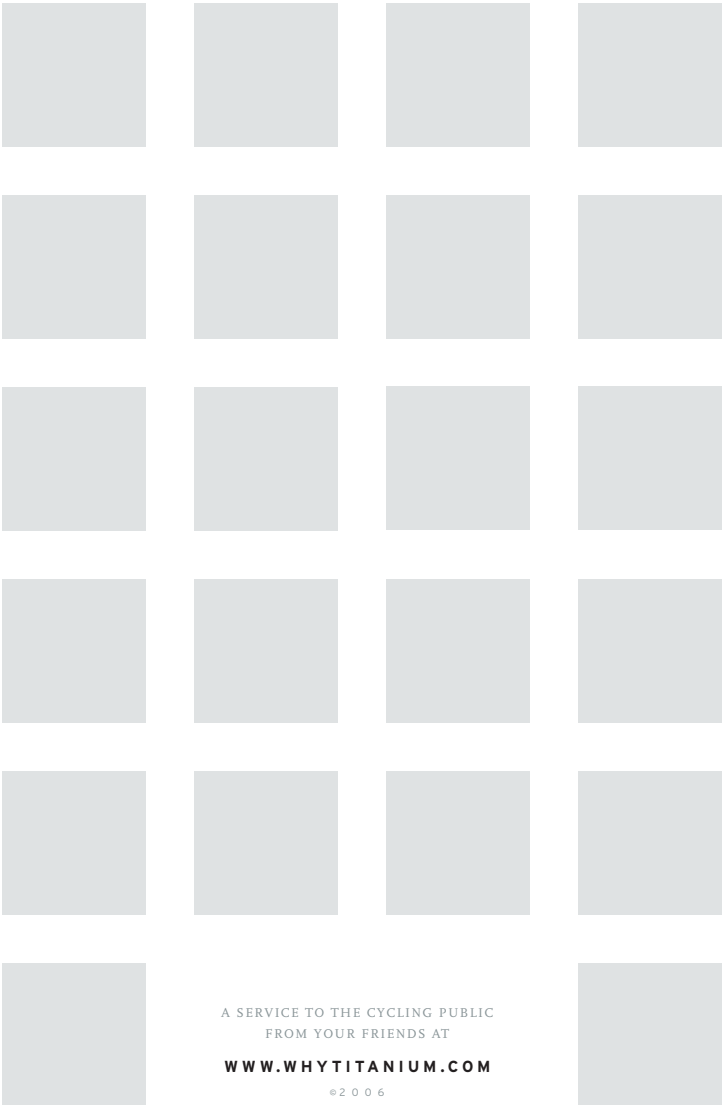

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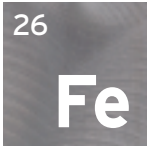
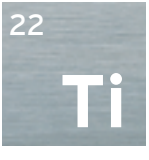


KNOW YOUR BIKE FRAME MATERIALS

A HANDBOOK



WHAT MATTERS?

A cyclist can sum up the properties of a bicycle frame in 4 categories:

1) WEIGHT
2) LONGEVITY
3) RIGIDITY
4) COMFORT

Weight

The lighter the bicycle is, the easier it will be to propel. This is a basic "given" that we all understand, but we're also all aware that the penalty we pay for low weight is often reduced strength and reduced performance. Is there such a thing as a bike that is too light? If it's going to snap the first time you fail to see a pothole, or it bends so much under pedaling stresses that it feels like you're running underwater, then yes. We're looking for low weight without compromising performance or strength.

Longevity

When you're hurtling around hairpin no. 15 on the way down Alpe d'Huez, with another seven corners still to come, you need to know that you're riding a bike that's not about to succumb to the pressures of the road. You need to be confident that the bike you're riding today is essentially in the same shape it was when you rolled it out of the garage that first time two years ago. Or twenty years ago. It's important.

Rigidity

Imagine riding your bike with your legs made of jelly. OK, if you've ridden over the 17 cobbled bergs of the Tour of Flanders in quick succession, you'll already know what it's like to ride your bike with legs made of jelly, so scrap the imagination part. Well, the same thing goes for your bike frame: the less it flexes under torque, the more forward motion you're going to get for the effort you're putting in.

Comfort

If you bend over and let your mom repeatedly kick you in the rear, sooner or later it's going to start to hurt. If your mom wears fluffy slippers, it may take longer to reach this point. If you can persuade your mom not to do it in the first place, you're on to a winner. Don't buy a bike that feels like your mom is kicking you in the rear every time you ride it.

FRAME MATERIALS

The modern cyclist has a choice of four materials when choosing a new bike frame: **steel, aluminum, carbon fiber,** and **titanium**

Steel

Twenty years ago, virtually every bike was made out of steel in one form or another. Ten years ago, there were still more steel bikes being sold than aluminum, carbon fiber or titanium put together. In the twenty-first century, things are a bit different. Why?

The good things about steel are that it's easy for a frame builder to work with, it has great strength and good absorption qualities. The problems start when you want to build a lightweight steel frame. As less metal is used, the frame loses it's strength and rigidity. As a result, a lightweight steel frame can have a shorter life but, more significantly, will flex a great deal under pressure, losing valuable power from the rider. In addition, this effect increases as the frame ages: we've all heard a story of how Mr. Smith has a fantastic old frame built out of 531 by John Doe in 1960 that's still going strong...it may indeed still be going, but it will categorically not feel the same as it did the day Joe Fishface finished his welding. The flex increases with age. And of course, we all know that steel can rust.

Where weight is not an issue, steel remains a great choice, i.e., for fully laden touring bikes. It will last well, it will be comfortable, it can be renovated or fixed relatively easily.

There are many different forms of steel, each with it's own properties, but if we were to make a generalization we could sum up steel frames like this:

- Weight: relatively heavy if we want to preserve strength.
- Longevity: good, although stiffness tends to recede over the passage of time.
- Rigidity: heavier frames will be stiffer than lighter frames.
- Comfort: renowned for it's absorption qualities.

Aluminum

Most lower-end bikes today are made of aluminum. It's come on in leaps and bounds since it's first forays into the main market place in the 1990's. Originally castigated for being brittle and uncomfortable, aluminum frames have developed at a pace into the new millennium.

The prime features of a good aluminum bicycle frame are low weight and high rigidity. The resulting machine is a highly responsive, fast accelerating weapon. However, problems remain. aluminum has never been the most absorbent of bicycle materials. The introduction of carbon forks has gone a long way toward cementing aluminum's popularity: most road shock travels up from the road at about 45 degrees, depending on the rider's speed. A carbon fiber fork can significantly reduce the amount of road shock transmitted to the rider, and is a vast improvement on an uncomfortable aluminum fork or a heavy steel fork. On longer rides, aluminum owners will still often complain of neck, wrist or shoulder pain, a sore lower back, or just ask for three pairs of padded shorts.

Longevity is compromised, paradoxically, by the strength of aluminum. It's not very pliable, so stresses, knocks and accidents are more likely to cause a break than with other frame materials. A five-year frame guarantee is the norm, and many lightweight aluminum framesets carry a rider weight limit or an extremely curtailed warranty period, signifying a greater likelihood of frame failure.

Where comfort and/or longevity are not issues, the aluminum frame is a winner, e.g., short time trials, track racing. Again, there are numerous different aluminum tubesets available, all with slightly different capabilities, but we can draw some general conclusions:

- Weight: aluminum frames can be built to a very low weight, but not without compromising longevity.
- Longevity: people who want to be riding the same bike in ten years time do not buy aluminum.
- Rigidity: excellent power transfer capabilities.
- Comfort: longer rides will be enjoyed more on other materials.

Carbon Fiber

Bicycle designers and engineers now have clear understanding of the capabilities, strengths and limitations of carbon fiber. The emerging popularity of carbon fiber as a primary frame material has been advanced by a number of converging factors which include the somewhat myopic quest for the pinnacle of stiffness; a drive to make lighter bikes; and a more fashion-oriented desire to produce aesthetically pleasing framesets that look nice on the shop floor. Of course, there is always a "newer is better" perception that is promoted and perpetuated by heavy investment in marketing.

Carbon fiber meets the challenges of producing bikes that are light and stiff. Where it fails to deliver is in its ability to enhance the true riding characteristics of any given bike. This has left many experienced cyclists with the feeling that, while carbon fiber bikes feel light, stiff and fast, the ride is largely lifeless and as unforgiving as low-end aluminum.

Carbon doesn't behave like a metal. It's strength and rigidity are directional. This means that a single strand of carbon fiber is as strong as can be in one direction, but has no rigidity at all in another. To build anything, bike frames included, it needs to be layered up in sheets, with the fibers pointing in different directions, then bonded together.

This is why carbon fiber is the ideal material for road bike forks. A bicycle fork is a fairly straightforward piece of equipment: we want it to be torsionally stiff, so we can lean the bike over in a corner without it flexing too much, but we want it to absorb shock coming up vertically from the road.

When it comes to frames, the equation is vastly more complicated. As a rider yanks on the bars, powers on the pedals and launches himself forward, numerous different directional forces ebb and flow through the frame, changing from one pedal stroke to another.

Here's a fact often overlooked by people talking about carbon frames. You will often hear carbon described as comfortable. In fact, inherently, carbon fiber has no shock absorption qualities. This comes not from the fibers themselves, but from the layers of resin—or glue, if you like—used to form the carbon fiber tubes. The more layers of resin, the more cushioning will take place when bumps are encountered. Unfortunately, there's a downside.The resin, in comparison to the fibers, is heavy. But we're about to get to the bottom of the Great Carbon Mystery...how come some people say it's comfortable and some say it's a hard ride? How come some carbon frames are light and some are heavy?

Answer: more resin = more comfort = more weight.

Durability of carbon fiber is perhaps the biggest area of concern. Crashes, or even dropping a carbon fiber bike may result in unseen damage to the integrity of the frame—damage that may result in sudden and catastrophic frame failure and serious injury to the rider. Recent litigation against carbon fiber products has led many bike manufacturers to issue stringent warranty statements that preclude them from any liability.

So can we say that heavier carbon frames are more comfortable than light ones? Generally speaking, yes we can. The longevity of carbon frames has sometimes been called into question over the

years. If there has been a problem, it has invariably occurred in the bonding process. Unsuitable resin or bad fits at the joining of tubes has led to 99% of failures in carbon frames. They are far better than they used to be as knowledge and experience have improved.

- Weight: can be made very light indeed, but often at the cost of comfort and strength.
- Longevity: variable. Difficult to repair.
- Rigidity: varies hugely from one design to another.
- Comfort: changeable, but heavier frames tend to be more comfortable.

TITANIUM

We were always told that we could have comfort, but not rigidity. We could have strength, but not low weight. It has always been a trade off. We've all heard the shocking generalizations: steel is comfortable, but flexy. aluminum has great power transfer, but will shake your teeth out. Steel will last forever, aluminum will snap when you least expect it. aluminum is light, steel is heavy. You can't have your cake and eat it too.

But you can.

The best titanium frames really can give you everything. Outrageous power transfer. Magic carpet smoothness. Unbearable lightness of being. Forever. How?

Titanium is incredibly strong, and it doesn't corrode. As long as the frame builder gets it right in the first place, and you don't go round riding into too many trees, your titanium frame ought to feel exactly the same in ten years time. Or thirty years time. Or sixty, come to that. Even if you do run into a wall, it can usually be fixed without too much fuss.

But it's the comfort thing that gets people scratching their heads. Titanium's flexy, isn't it? Durrrrr. No.

It's inherently absorbent, that's what catches people out. Shock prefers to travel around the outside of titanium molecules, not through the center like it would in, say, aluminum. The path of the shock is disrupted and altered, dissipating it's effects before it reaches the rider. So here's what you can do. You can build a titanium bike that accelerates like a dragster, but still smooths out the road.

And because it's such strong stuff, you don't need much of it. So you can make your bike unbelievably light, without compromising on the other features. Fiendish.

- Weight: unsurpassed.
- Longevity: will never break.
- Rigidity: great acceleration.
- Comfort: if you look up "plush" in the dictionary, it says "titanium frame".

Titanium: Durable & Enduring

Titanium is the most durable frame material available. It does not rust. It will not lose any of its performance properties over time. It is extremely strong and resilient.

You will age. Your components will wear out. Time will pass. Your titanium frameset will be as light, stiff, responsive and comfortable as the first day you purchased it. How safe would you feel on a swift descent after you dropped, crashed or bumped your carbon fiber frame? Titanium bikes alleviate those concerns and provide confidence to cyclists

"What does titanium feel like?"

The easiest way of answering this question is to get yourself on a ti bike. We can talk about it until the cows come home, we can explain how it works, we can draw diagrams, we can quote the pros...but a ride beats all of these.

For instance, titanium and certain carbon frames can both be accurately described as comfortable, but do they feel the same? No. Carbon deadens shock in a way that has been called "wooden"...put your ear on one end of a wooden bench and get a pal to tap the other end. You can hear it, dully, transmitting through the wood. Do this on a metal bench and your head will be ringing like you're Pete Townshend's guitar roadie. In contrast, titanium is comfortable in a much more "zingy" sort of way. If this sounds a bit crazy, ride one and see what we mean.

“Isn’t titanium flexy?”

No, not if you make your bikes right. You can make them more or less stiff depending on how much metal you use and where, but no, it’s not flexy. We can forgive those who jump to this conclusion after one ride, though—titanium bikes have a habit of fooling riders into thinking they’re flexy. Let us explain.

One of the comments most often heard from people hopping on to a stiff aluminum racing frame for the first time is, “wow, it just feels like it wants to go.” We know what they mean. That lively feel, the combination of low weight and the clear feel of every little nodule in the tarmac feels quick even when you’re doing a track stand at the traffic lights. Titanium doesn’t feel like that. You don’t feel the road. So your brain, which has been taught that comfort equals flex, tells you that you are on a flexy bike. It’s only when you get out of the saddle and launch yourself at that familiar little hill, or check your time the first time you complete that favorite circuit, that you will appreciate how quick your bike is.

For example, a certain well-known cyclist with numerous classic wins under his belt now owns a titanium bike. When asked, off the record, what he thought of it, he replied: “The first time I rode it, I thought it The world has gone mad with all of this titanium hype.” It was only after riding his new bike for a while that he realized he was going faster than he ever had on any of his pro team bikes. “Now I think it’s the best bike I’ve ever had.”

Remember: in titanium, the absorbency is in the structure of the metal, not in making the frame flexy.

Proprietary Titanium

There was a time when most major bike manufacturers carried a titanium frameset in their range, and many still do. Almost all of these frames are made of rolled and seamed titanium. The kind of tube that this process produces is relatively easy to work with, so it can handily be welded by the same production line as produces other frames in the manufacturers range. Unfortunately, this type of tubeset has to be made with fairly thick walls to keep it's strength and rigidity high. This in turn makes the frame heavier and loses much of that unquantifiable "zinginess" that makes ti frames so special. What you end up with is a frame that feels very similar to a very nice steel frame. So...err...why not buy a very nice steel frame?

3/2.5Al Titanium

The tube of choice for speciality titanium frame producers is cold drawn 3/2.5 Al, or 3/2 as we say. The key part here is that it's cold drawn: that means it's forced into a tube shape under unbelievable pressure from a single billet of titanium. This can make it intrinsically up to 45% stronger than the usual rolled and seamed stuff. In turn, that means less can be used, making the tube walls thinner, the frame lighter, and the titanium feel unmistakable.

6/4Al Titanium

The most advanced tube currently available is 6/4Al Titanium. This can make a tube that is 30% stronger again, even compared to the best 3/2. However 6/4 is notoriously hard to work with, and can't be cold drawn. It's made into sheets, then formed into tubes. As these don't even have to start their life as cylindrical, 6/4 is ideal for frame designs which demand a high degree of unusual shaping.

Other Titanium

There are a few other types of tube that fall into the gaps between the aforementioned types. 3/2 and 6/4 as described above were developed for use in the US aerospace industry and is produced to an unbelievably high level of "purity" and quality. Eastern Europe and China produce large amounts of titanium for non-specific industrial usage, which could be described as 3/2 or 6/4, but which, as yet, don't measure up to the same standards. A good analogy would be tire rubber. The rubber on a kid's trike is similar to the rubber used to shoe a 747's landing wheels...but face it, it just isn't the same.

Everyone! OK, excuse the obvious answer. Titanium is fast, light, strong and comfortable, we've established that. Other bikes have combinations of those features; few, if any, have all the attributes. The general rule of thumb is that the longer you spend on your bike, the more you will appreciate it being made out of titanium.