Cable Design

Audio Cable Design of Pear Cable Inc.

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PEAR CABLE

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Audio Cables Introduction

Sound is a very delicate form of energy. It does not take much to alter it from its original form. High-end audio is all about reproducing sound as accurately as possible to minimize the differences between a live performance and playback of a recording. Many people do not realize that audio cables are another electrical component just like the amplifier or CD player being used in their audio system. A poor cable choice is capable of removing or distorting all the detail and nuance of a recording that the listener wants so desperately to hear. This is about making the hairs on the back of your neck stand on end. For those who have not experienced that feeling while listening to music, an unexplored world awaits you.

There are three main factors to consider when assessing the performance of an audio cable: cable design, materials, and manufacturing quality. Each of these factors contributes to the overall sound of the final product. This technical section addresses in detail the guidelines and thought processes followed by Pear Cable in the development of their cables.

Cable Design

Geometry and Construction

The geometry and construction of a cable are some of the most important elements in determining the effectiveness of the final product. When considering the geometry of a cable, many different, but related factors come into play. The interaction between the various elements means that it is very difficult to change one aspect of the cable and not have it affect something else. Pear Cable considers the proprietary cable geometry that it has developed for ANJOU interconnects, including "Perfect Twist" conductor arrangement, to be one of the most innovative and effective designs available. While most of the design is proprietary, we can tell you that each cable (not pair) has 25 separate parts not including the connectors! Of course having a lot of parts does not necessarily make a cable better than another cable. We simply want to make the point that a very unique and effective geometry has been developed for ANJOU that you will not find anywhere else.

High capacitance is potentially one of the most deleterious properties of an audio interconnect. The reasons why capacitance can cause problems are covered in the "Electrical Properties" section of this article. Every effort was made to minimize cable capacitance in ANJOU interconnects, and the result is one of the lowest capacitance interconnect cables in the world. Low capacitance is achieved through the use of small diameter conductors, large conductor spacing, and low overall dielectric constants. The trick is to accomplish all of this without compromising the mechanical integrity of the cable, or creating other problems.

One of the more popular high-end cable designs available today from a number of manufacturers employs "Teflon® air tubes". The driving force behind these designs is the desire to create a low capacitance interconnect cable. *These cable designs are a prime example of the wrong way to create a low capacitance cable!* By letting conductors rest loosely inside a tube, several major problems are created simultaneously. The biggest problem is that the conductors are now free to move relative to the insulation and each other. This allows the creation of noise through several different mechanisms that are discussed in the "Noise" section. The noise will not simply be random, but instead it will occur in conjunction with the music, creating unwanted distortion.

In addition to this noise, the lack of a mechanically stable system means that the cable electrical properties are not fixed. Since the conductors are free to move within their "air tubes" they will move every time the cable is flexed or positioned. This means that when you deploy a pair of cables, each cable will have slightly different electrical properties, depending upon how the conductors moved inside the tubes. ANJOU interconnects have been specifically designed to avoid these problems through the use of an extremely stable mechanical design.

Finally, the air tubes will promote corrosion of the conductors. Both silver and copper conductors will corrode in air. Needless to say, corrosion is not good for the cable performance. ANJOU cables completely avoid this problem through the use of gold conductors. More information about corrosion is provided in the "Conductors" section.

Going back to the capacitance, having more air and less plastic is one way to lower the capacitance of a cable. However, using "air tubes" to achieve low capacitance is clearly a bad way to go. Pear Cable has gone to great lengths to ensure that ANJOU interconnects have a low capacitance, but are fully mechanically stable. The proprietary "Perfect Twist" geometry maximizes the amount of air present near the conductors, but does so in a fashion that ensures full mechanical support of both the conductors, and the dielectric material. Again, for more information on why it is so important for a cable to be mechanically stable, please see the "noise" section.

In addition to low capacitance and mechanical stability of interconnect cables, conductor design is very important. Pear Cable uses two 36 gauge, solid gold conductors for its ANJOU interconnects. These two conductors are arranged in a "balanced" configuration. While there can be applications where more than two conductors would be desirable for an RCA interconnect, generally it only adds to unwanted cable capacitance. Solid conductors are used instead of stranded to avoid the myriad of problems that can arise from the use of stranded conductors. At the very least, stranded conductors provide an unstable mechanical environment which will contribute to a variety of noise problems. The small diameter of the conductors is good for two main reasons. It reduces cable capacitance and it eliminates concerns over skin effect. For a definition of skin effect please see the "Electrical Properties" section of this article.

While it is unfortunate that more details about ANJOU cable geometry and construction cannot be disclosed for confidentiality reasons, we hope that some light has been shed on the rationale behind the overall design philosophies. It is important to note that every single component in ANJOU interconnects has a purpose. The construction is guided solely by functionality and nothing else. The primary goal is, of course, the best possible sound quality.

Electrical Properties

This section is intended to define some of the more commonly referred to electrical properties and the roles that they play in audio cables. Many people fail to realize that cables have electrical properties just like any other electrical component in their system. Understanding these electrical properties is a necessary part of the cable design process. The statement made by far too many audio companies that electrical properties do not matter in audio cables is simply false.

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Resistance

Electrical resistance is the degree to which an electrical component resists the flow of current. One of the most basic electrical equations is the relationship between Voltage (V), Current (I) and Resistance (R). V=I*R

In analog interconnect cables resistance is essentially unimportant. The signal traveling through an interconnect cable is primarily voltage, with very little associated current, due to the extremely high input resistance of audio components. Any reasonable resistance will have almost no impact on the signal strength. For this reason, it is perfectly acceptable to use small gauge wire in interconnects. For loudspeaker cables, the opposite is true, because they are carrying large amounts of current with relatively low voltage. This means that in loudspeaker cables large gauge conductors are essential to good performance.

Capacitance

Capacitance is the next basic electrical property. It is one of the most important electrical properties of an analog interconnect. Strictly speaking, capacitance is the ratio of charge to voltage. Or in other words, it is a measure of the amount charge per unit voltage that an object can reach.

Capacitors can store energy or release it. The higher the value of the capacitor, the more energy it can store or release. If a voltage is applied to a capacitor the capacitor will take up energy based on its capacitance until it is at the same voltage as the voltage source (assuming the voltage source can supply energy). Conversely, if the voltage drops below the voltage of the capacitor, it will release energy until the voltage has again equilibrated. Because of this very basic property, capacitors fundamentally resist the change of voltage.

Analog interconnect signals are not very "strong" in the sense that they are primarily voltage with only a small amount of current. This makes the audio signal very susceptible to capacitance. Audio signals are alternating in nature (the voltage oscillates between positive and negative). The frequency at which the signal oscillates is the frequency of the sound. The faster the oscillations occur, the larger the effect of the capacitance.

ANJOU interconnects have one of the lowest capacitances of any cable in the world. This low capacitance reduces the amount of energy absorbed and desorbed by the cable as the audio signal passes through it.

Inductance

Inductance is the final basic electrical property. It is the property that opposes the change of current in a circuit. The explanation for the resistance to changes in current lies in the formation of a magnetic field whenever current flows. The larger the amount of current, the larger the magnetic field. The magnetic field is a form of energy. When current begins to flow, the magnetic field begins to form, which takes energy directly out of the current. This essentially slows down the increase of current because the magnetic field must be increased at the same time. Conversely, if current is decreased, the magnetic field must decrease in size, which releases energy back into the current flow. This release of energy means that the current keeps flowing at the higher level a little longer than it would otherwise.

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Just like capacitance delays changes in voltage, inductance delays changes in current.

As stated previously, analog interconnect signals are composed primarily of voltage with very little current, and loudspeaker cable signals are composed primarily of current with very little voltage. Because of this, inductance is relatively unimportant for analog interconnects, but crucial for speaker cables. The name of the game is to absorb as little energy from the audio signal as possible. Comparing the relative strength of the signal voltage to the signal current enables a cable designer to focus on the appropriate cable properties. This understanding is paramount when creating quality audio cables.

Impedance

Impedance is similar to, but not to be confused with, resistance. Impedance and resistance both have the same relationship with voltage and current. That is to say, impedance is the degree to which an electrical component resists the flow of current. The difference between impedance and resistance is that resistance is only a valid term for steady direct current (current that does not have an associated frequency). If a signal has a frequency associated with it, the resistance to current flow also has to take into consideration the effects of capacitance and inductance. This is impedance. If the frequency of a signal is anything but zero (DC), than the term impedance must be used instead of resistance. This is primarily an issue of semantics.

Characteristic Impedance

To understand the definition of characteristic impedance, one must begin by thinking of a cable that is infinitely long. The idea behind an infinitely long cable is that a signal propagating down the cable will never reach the end. If the signal can never reach the end, then it obviously cannot be affected by what is connected to the end of the cable.

If a small piece is cut off of the infinitely long cable, the long section must still have the same impedance because it is still infinitely long. Now, if the small piece is terminated with a component that has the same impedance as the infinitely long cable, from an electrical standpoint, it will look just like the infinitely long cable. Because the small cable now looks like the infinitely long cable, no information that is sent down the short cable can be reflected back. This value of impedance, of the infinitely long transmission line, is called the characteristic impedance.

The characteristic impedance will vary as the frequency varies. However, at high frequencies, the characteristic impedance stabilizes and becomes constant. It is this high frequency impedance that is commonly referred to as the characteristic impedance.

Making a cable with the characteristic impedance of the component to which it is attached is extremely important to avoid signal reflection. This is why digital interconnects should always have the correct characteristic impedance. However, if the wavelength of the signal is large relative to the length of the cable, then reflections are not an issue. This is the case in the audio frequency band. This is why there is no impedance standard for analog audio connections or equipment. Even if one wanted to match the impedance, it would be extremely difficult because the characteristic impedance is changing with frequency in the audio band. Reflections are simply not an issue with analog audio.

Skin Effect

The skin effect is the tendency of current to travel on the outside of a conductor as the frequency rises. The explanation can be derived from the influences of inductance on the signal. As the frequency of a signal rises, the magnetic field pushes the current to the outside of the conductor. As the current is pushed to the outside of the conductor, the effective cross-sectional area of the conductor is reduced, which increases the impedance.

The impact of this effect on audio transmissions is that high frequency information sees higher impedance than low frequency information. As the signal passes through the cable, this causes the high frequency information to be absorbed as heat. Obviously this is not a good situation. However, the smaller the conductor, the lower the impact of the skin effect. If a suitably small conductor is utilized, the skin effect can be virtually eliminated.

The very small (36 gauge) conductors used in ANJOU interconnects are small enough to eliminate any high frequency attenuation concerns.

Don’t buy plated conductors!

Many audio cable companies plate or clad their conductors with a different metal than the one used in the core. Usually this is either silver or tin plating on copper. All metals have different resistivities. Because the skin effect will push high frequency information to the outside of the conductor, it will encounter the different metal on the outside of the conductor. In the case of the silver (which has a lower resistivity than copper), the high frequency signal sees a lower impedance than the low frequency information. This will cause a distortion in the relative amplitudes of the high and low frequencies of the audio signal.

In the final analysis, it doesn’t matter what combination of metals is used. It is not a good idea to allow the high and low frequency information of the signal to see different impedances. The reason why silver and tin plated copper was invented was to reduce the corrosion rate of the wire. Do not be fooled into believing this relatively cheap wire was developed for some special audio application.

Noise

Noise in audio interconnect cables is caused by a variety of phenomena and can create more damage to audio signals that many realize. When most people think of noise, they think of random background hum that simply raises the general noise level. In fact, noise can be generated in tandem with the music signals, which can have an even more deleterious impact than random or 60 Hz hum. Pear Cable interconnects are specifically designed to mitigate all types of noise.

The more commonly considered forms of noise are electric, magnetic, or the combination of both. When electric or magnetic fields are formed close to a potential receiver (i.e. the cables) they are generally considered independently. If, however, the noise is being generated far away, the two are considered together and called electromagnetic noise. The source of this type of noise is usually other electronic components or electrical devices or wiring.

If, for example, a power cord is run next to an audio interconnect, it is highly possible that the magnetic field produced by the power cord will create a 60 Hz hum in an audio system. For this

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reason, all other system wires should be kept away from audio interconnects. ANJOU interconnects have a proprietary “Perfect Twist” conductor arrangement that provides excellent rejection of both electric and magnetic fields. Because of this, ANJOU interconnects do not employ a separate active shield. The presence of an outer shield increases the capacitance of the cable unnecessarily.

The types of noise of greatest concern to Pear Cable are the non-random types that are generated in tandem with the musical signal. This non-random noise comes from mechanical vibrations within the cable itself. It cannot be overly emphasized how important it is to have a mechanically stable cable. There are at least 3 separate mechanisms for movement within a cable to cause signal distortion.

Triboelectric effect
Movement relative to an electric field
Movement relative to a magnetic field

It is important to realize that there are two separate energy sources for this vibration.

The first energy source comes from the loudspeakers themselves. As music is played, the vibrations in the air (sound) vibrate “hairs” in your ears (so you hear the sound), as well as everything else in the room. This vibration includes your audio cables. This mechanical vibration, induced by the sound itself, is a major enemy of cable producers. Unfortunately, this problem is rarely talked about, and frequently overlooked.

The second energy source comes from the current running through the audio cables. As mentioned previously, the current will produce a magnetic field. Since all of the wires in our audio systems have current running in opposing directions (+ and – lead, this applies to AC as well) opposing magnetic fields are set up in the conductors. These opposing magnetic fields mechanically push the conductors apart, thus causing mechanical vibration. This is a major design consideration for loudspeaker cables. However, in audio interconnects, the current is so small, that this effect can truly be neglected, so we will not elaborate on this second mechanism for now.

What is important about both of these sources of noise is that they are not random. Both effects are a direct result of the sound being made by the audio system and are therefore making noise in sync with the music. As soon as noise is made in sync with the music, serious distortions become a concern. This kind of distortion is far more bothersome than random noise, because in the real world we are always surrounded by some amount of random noise. The finest concert halls in the world and finest listening environments ever constructed will always have noise present. In fact, the complete lack of background noise sounds very unnatural. Anyone who has been in an anechoic chamber will attest to this fact. Of course, in the final analysis we go to great efforts to assure that our cables reject as much noise as possible, but it is important to understand where the more serious problems lie for audiophiles.

Now that we have established the idea that mechanical vibrations can cause serious problems, let’s go back to understanding the 3 mechanisms.

The triboelectric effect is a familiar phenomenon to most people (though not by name). When two different materials are rubbed together, an electrostatic charge builds up, in equal amounts but opposite charge, on the two materials. This is what happens when a person walks across a carpet. If the air is dry enough, the person will build up a charge of literally thousands of volts.

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When that person goes to touch a doorknob, a spark will be generated as the charge is equalized. The ease at which the charge is transferred depends upon the materials in question. Electrons are literally being rubbed off of one material and on to the other material. This is a major problem for microphone cables because they are constantly in motion. In analog interconnects, as sound vibrates the cables, the conductors will move differently relative to the dielectric material. As this happens, the vibration will create electron transfer between the conductors and the dielectric material. This constitutes a direct form of distortion, and again, it will happen in sync with the music. Very bad!

Going now to the “movement relative to an electric field”, this is another mechanism for causing distortion when a cable vibrates. Every cable has a certain capacitance. As an audio signal travels through a cable it is constantly charging and discharging this “capacitor”. In general, as covered in the “Electrical Properties” section, it is desirable to minimize the cable capacitance in order to minimize this effect. The cable capacitance is heavily dependant on the geometry of the cable. If the conductor of the cable moves relative to the dielectric, the cable geometry has changed and thus the capacitance has changed. The change in capacitance means that charge must be either absorbed or desorbed from the conductor. That energy will be either added or subtracted directly from the audio signal, and again it will happen in sync with the music. Of course the change in capacitance will be small, but the rate of change can be fast. Rapid changes in charge are rapid changes in current which will harm the fundamentally low current interconnect signal.

Finally, “movement relative to a magnetic field”, is a well-known mechanism for creating current. The mechanisms behind inductance work both ways. That is to say that if current flows through a wire a magnetic field is produced, and conversely if a wire is moved relative to a magnetic field a current is created. Because of this, mechanical vibrations of conductors relative to the magnetic fields set up by their own currents will cause noise pick up. While it has already been stated that the current in an interconnect is too small to create a large enough force between the conductors to worry about, the vibrations caused by the sound waves do have the potential to move the conductors enough for this to matter. Therefore, because of mechanical vibration induced by the loudspeakers, we must consider this source of noise not just in loudspeaker cables, but also in interconnects.

How do we solve harmonic noise pickup?

The best way to reduce the amount of harmonic noise pickup is to ensure that a cable is mechanically sound. Again, loosely resting conductors in insulating tubes is just about the worst possible design when it comes to mechanical stability. The proprietary “Perfect Twist” technology used in ANJOU interconnects was specifically developed to allow the fabrication of a low capacitance cable that is mechanically stable. It is important for a cable to not only be mechanically rigid, but also well damped. Without appropriate damping, even a “strong” cable will resonate at various frequencies. Adequate damping will increase the amount of energy required to vibrate cable components. ANJOU interconnects employ a braided Kevlar outer layer which is compressed onto the inner cable structure by the outermost plastic sheath. Kevlar is unique in its ability to provide an extremely high tensile strength with flexibility. It is this Kevlar layer which provides much of the necessary damping force to the final cable.

In addition to the proprietary “Perfect Twist” technology, and Kevlar/Sheath damping system, special attention it paid to the cable ends. Of course the connector is simply an extension of the conductors, so if there is any vibration of the cable relative to the connector, noise will be

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generated. The setscrew clamping system employed on the connectors ensures that a strong connection is made between the connectors and cable. The final result is a connection that is as free of problems as the core cable.

From the beginning of the design stage of ANJOU interconnects the negative effects of mechanical vibration were considered. The final result is a completely unique cable that is enormously stable and well damped. How well does your cable manufacturer deal with mechanical stability?

Materials

Conductors

Just as one might expect, the conductors of virtually any cable are important to the cable performance. In the case of audio, a very delicate signal attempts to pass through them without being harmed. The characteristics of the audio signal determine what types of materials are best suited for the particular cable in the connection. In this section, audio interconnects, and specifically ANJOU interconnects, will be discussed.

In order to select an appropriate conductor material, one must first understand the signal passing through it. In the case of an audio interconnect the signal usually peaks in the range of 0.3 – 2.0 Volts. The input impedance of the preamplifier or amplifier receiving the signal is high, frequently in the neighborhood of 10,000 Ohms. This means that the amount of current traveling through the cables is extremely small. The interconnect cable, is therefore transmitting a signal composed primarily of voltage with a little bit of current. The impact of the conductor material on this signal will be examined in this section.

ANJOU interconnect conductors are made from pure solid gold. The primary reason for doing this is to prevent oxidation of the conductor surface.

All of the most commonly used conductor metals (copper, silver, tin, nickel) will oxidize or corrode at room temperature in air. Please note that the primary corrosion of silver at room temperature is with sulfur, which forms silver sulfide. Silver can also be oxidized by ozone to form silver oxide, but the primary layer that forms on silver exposed to air is silver sulfide. Many cable manufacturers falsely state that the "silver oxide" layer that forms on their conductors is O.K. because it is conductive anyway. This is just plain wrong. Silver sulfide is actually an electrolyte, which allows the movement of silver ions and has actually been proposed for "atomic switches". It is not something that you want on the conductor surface.

In the case of copper, copper oxide forms when metal is exposed to air. Copper oxide is an insulator, and has entirely different properties from either the copper, or the cable insulation. A high magnification Scanning Electron Microscope (SEM) image of an oxidized copper wire surface is shown in Figure 1.

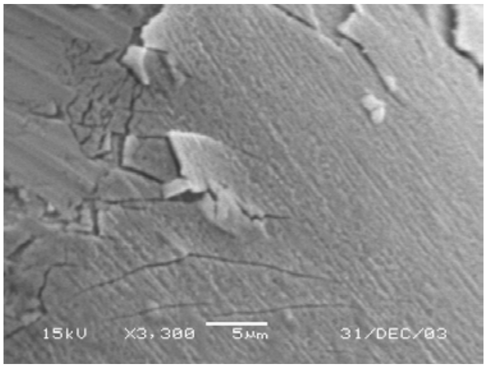

Figure 1: Oxidized Copper Wire

So why does it matter if there is a little corrosion of the conductor surface?

Due to the inherent low current nature of interconnect signals, the capacitance of audio interconnects is extremely important. Again, the details of capacitance are explored in the "Electrical Properties" section. However, in brief, the capacitance is most affected by the insulation closest to the conductor. Corrosion, being directly on the surface of the conductor, is in the most sensitive area possible when it comes to the capacitance. Surface corrosion causes general increases in the capacitance as well as non-linearity's in the capacitance. Corrosion of interconnect conductors is unacceptable.

Insulation is not a perfect seal!

One of the popular methods of achieving low capacitance in cables today is to use insulation air tubes. These designs are clearly the most susceptible to conductor oxidation or corrosion. They also have serious mechanical stability problems, which are covered in the "Geometry and Construction" section. These interconnect designs should be absolutely avoided.

It is important to understand that all insulation materials leak air. Even if the insulation is directly in contact with the conductor, oxygen and other gases will penetrate the insulation and corrode the conductor. This property of the insulation is known as the "permeability", and can be easily obtained from insulation manufacturers. For example, the permeability of oxygen through Teflon® FEP is 11,600 $cm^3/m^2*24h*atm$. The diffusion of oxygen, or other gases, through the insulation will be small, but the conductors *will* oxidize over time.

The gold that Pear Cable uses in its ANJOU interconnects is 99.99% pure, and is of the finest quality available. The conductors are custom manufactured for Pear Cable by a semiconductor supplier to ensure that the highest quality standards are adhered to. Smooth, defect free conductor surfaces are assured, and the drawing direction of the wire is used to set the directionality of the cable.

The end result for the conductor material used in ANJOU cables is a metal that is absolutely stable. Unlike many other cables, the conductors will not degrade over time. The use of pure gold delivers overall performance that cannot be rivaled.

Insulation Material

Cable insulation has a dramatic impact on the performance of any audio cable. Insulation can be thought of as having two distinct but intertwined elements; the materials, and the geometry associated with those materials. This section will deal primarily with the materials themselves, while the insulation architecture is covered in the "Geometry and Construction" section.

The primary function of insulation is of course to prevent the cable conductors from short-circuiting with one another. In order to do this, insulation must be electrically non-conductive. It is not difficult to find materials that satisfy this requirement. Beyond being non-conductive, it is desirable to have insulation that does not absorb energy. One of the primary measurements of how much energy an insulation material will absorb is called the *dielectric constant*. The dielectric constant has a direct impact on the capacitance of the cable, which is discussed in detail in the "Electrical Properties" section. In brief, capacitance describes the storage and discharge of voltage. When trying to convey an audio signal through a cable, this storage and discharge of voltage is a direct form of distortion and should be minimized.

In order to minimize energy storage, it is desirable to have the insulation dielectric constant be as low as possible. A material that absorbs absolutely no energy has a dielectric constant of 1. The only "material" that meets this criterion is actually the absence of material, or a perfect vacuum. Air is close to a perfect vacuum with a dielectric constant of only 1.0006. Teflon® has the lowest dielectric constant of all plastics, which is why many audio cable manufacturers use it. While there are many different types and grades of Teflon®, the three most common forms are PTFE, FEP, and PFA. Although variations will occur depending on the grade and manufacturing process, the most commonly accepted dielectric constants are listed in Table 1.

Table 1. Dielectric Constants of Insulation Materials

Vacuum	Air	PTFE	FEP	PFA	Kapton®
1.0000	1.0006	2.1	2.1	2.1	3.5-3.6

PTFE is the original Teflon® formulation, and is the material employed in Pear Cable products. The three different types of Teflon® listed in Table 1 all have virtually identical dielectric constants. This makes them all good choices for audio cables. More importantly, the dielectric constant is stable over a wide range of conditions. Unlike most other plastics, from 1 Hz to over 1 GHz the dielectric constant remains the same. This stability is absolutely crucial to achieving undistorted audio transmission. Most other materials have peaks and valleys in the dielectric constant across the audio frequency band, which causes a plethora of corresponding distortion problems.

While Teflon® is the best plastic material to use as an insulator, it becomes readily apparent when looking at Table 1, air is the best practical dielectric possible. In fact, the insulation of Pear Cable products is designed in such a way that most of the cable is air, and Teflon® is only used where necessary. This is known as the cable architecture, and is covered in the "cable design" section.

Foamed Teflon® is bad!

There are many ways to create a Teflon®/air insulation structure, and Foamed Teflon® is one of the more common methods. Foamed Teflon® is exactly what it sounds like; namely Teflon® that has air bubbles injected into it. These air bubbles lower the overall dielectric constant of the insulation. It is commonly used because the mixture of air and Teflon® can essentially be treated as one material, making fabrication processes simpler. One of the biggest problems with this insulation technique is that the *overall* dielectric constant is reduced, but the randomness of the bubbles creates a myriad of local anomalies. Large air bubbles on the surface of conductors are unpredictable and the associated dielectric constant variation causes a variety of transmission problems. In fact, it is well known that this phenomenon slows down data transfer in Ethernet cables. Foamed Teflon® is never used in Pear Cable products and should not be used in any high fidelity audio cables.

Kapton® is not better than Teflon®!

Kapton® is a high performance polymer that has a number of high tech applications, but audio should not be one of them. To begin with, as shown in Table 1, the dielectric constant is dramatically higher than Teflon®. This leads to higher capacitance, the effects of which are discussed in detail in the "capacitance" section. In addition to being high in general, the

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dielectric constant is also variable over the frequency range of audio systems. According to the manufacturer (Dupont), the dielectric constant for Kapton® Type HN is approximately 3.54 at 100 Hz and goes down steadily to 3.46 at 100,000 Hz. This means that the high frequency components of your music would see a different cable, electrically speaking, than the low frequency components. Not good! However, the biggest problem with Kapton® is its affinity for water. The manufacturer clearly states, "Kapton® polyimide film is made by a condensation reaction, therefore, its properties are affected by water." This has a disastrous effect on the dielectric constant as the humidity changes. Table 2 displays the affect of humidity on Kapton® Type HN, as provided by the manufacturer.

Table 2. Kapton® Type HN

Relative Humidity (%)	Dielectric Constant
0	3.0
30	3.3
50	3.5
80	3.7
100	3.8

The impact from the humidity is tremendous. This means that if your audio cables are made using Kapton®, you are literally listening to an entirely different cable, depending upon the humidity of the listening room. In comparison, with Teflon® there is "no measurable dielectric change with humidity".

Kapton® has its uses in a variety of applications due to its ability to perform in extreme temperature environments and properties such as corona resistance, but it should not be used in audio cables.

Pear Cable is dedicated to identifying the best possible materials for use in our cables. Insulation material is a very critical element in the overall performance of an audio cable and we have gone to great lengths to ensure that only the best materials are employed.

Connectors

Do not overlook the importance of having a good connector! While at first this may seem to be a trivial aspect of an overall cable design, it is overlooked at ones own peril. There are a numbers of factors to be considered in the selection of a quality connector.

ANJOU interconnects utilize WBT Topline crimping RCA connectors. While many manufacturers utilize WBT connectors in their products, few employ Topline connectors due to the expense. Careful evaluation has led Pear Cable to believe these connectors to be the finest available in the world, and thus has included them in the ANJOU interconnects.

Do your connectors address all of these issues?

Cold welding is the best way to make a connection between two pieces of metal. Cold welding is a welding process performed under high pressure or vacuum without the use of heat. Precision "dies" and the appropriate amount of pressure allow two separate pieces of metal to bond on the molecular level. When performed properly, the resulting joint is gas tight and often stronger than the parent materials. This is the process used to connect ANJOU wires to a suitable crimp, which is then connected to the primary plug via a setscrew. This is superior to resistance welding or soldering due to the fact that no heat is used. Heat causes unwanted deformation, and or oxidation, of the associated metals.

Motion is bad!

When you are listening to your stereo or home theatre, literally everything in the room is vibrating with the sound, including your cables. This fact is what enables spies to listen to conversations inside a remote building by focusing a laser on a window. The laser is used to measure the frequency and amplitude of the vibrations of the window, which gives them the sound being generated inside the room. In order to prevent this vibration from turning into sound damaging noise, it is critical to prevent cable components and connectors from moving relative to one another. Triboelectric effects as well as electromagnetically induced currents will cause distortion and noise in the cables. For more information on these phenomena, please see the “Noise” section. For this section, it is only important to understand that motion of the connector relative to the component, or cable, is bad.

WBT connectors employ a patented collet type locking system to secure the connector to the RCA jack. This collet system is very similar to the way that a milling machine holds a cutting tool. It is the strongest connection available in any type of RCA connector. This ensures that the connector will not move relative to the component.

On the other end of the connector is a precision-machined setscrew. Far more robust than the setscrews used on many competing connectors, this setscrew can be used to clamp the end of the cable tightly. In addition to the setscrew, ANJOU cables employ a final heatshrink jacket to further dampen any vibrations or movement between the cable and the connector.

Finally, like the cable to which it is attached, the WBT Topline connectors use only the finest materials available. German engineered with high copper alloys, multi-layer gold plating, and Teflon® insulation, performance is assured.

A high quality cable is nothing without a good connection. How do your connectors stack up?

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Manufacturing Quality

Any cable design is only as good as the manufacturing process that produced it. Cable design can be optimized and the best materials in the world can be selected, but if the design cannot be reliably produced, the effort is for naught. Pear Cable is dedicated to ensuring high precision cable fabrication.

Do not purchase handmade cables!

The audio cable industry has a relatively large number of small-scale manufacturers. Unfortunately, many of these manufacturers make their cables by hand. Handmade cables simply cannot match the repeatability or precision of cables made by machine. Handmade is something to look for when buying a piece of art, not an electrical component.

All Pear Cable ANJOU cables are made on precision custom designed machines.

The unique design and geometry that was developed for ANJOU interconnects does not lend itself to being manufactured on conventional cable equipment. Because of this, Pear Cable designed and built its own equipment from scratch. While developing custom machinery represented a significant investment to Pear Cable, there is simply no other way to ensure a quality product. This proprietary equipment enables the “Perfect Twist” geometry to be produced.

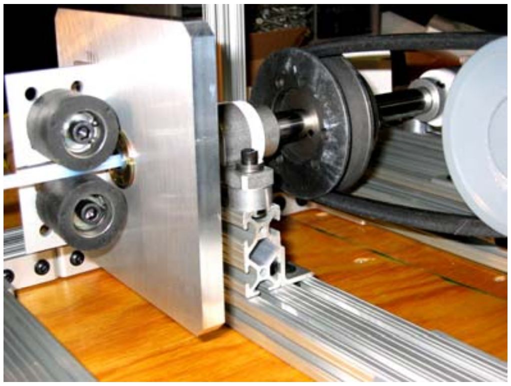
Figure 2: Pear Cable Machinery

Once an overall cable architecture has been identified, the product enters the engineering phase. From the beginning of the engineering phase through the development of the manufacturing equipment, everything is designed using state of the art Computer Aided Design (CAD) software. The equipment has been designed to hold critical elements such as conductor spacing to within +/- 0.001”. This level of accuracy is necessary to ensure that the manufactured cable meets the design spec, and that every cable is reproduced in a repeatable fashion.

When considering the purchase of a new cable, think about the stability and accuracy of the manufacturing process. How concentric is the conductor relative to its insulation? If a product consists of many tubes or conductors, how accurate is the spacing between the tubes or conductors? How many twists or braids are there per meter? How much variation exists between each twist or braid of the conductor? What will happen when I bend the cable? How well controlled is the diameter of the conductor? These are all valid questions to be asking a cable company. In the case of loose conductors within a tube, was the design intent to have both conductors as close together as possible or as far apart as possible within the tubes? Both conditions are possible if the conductor is not fixed. How will the different positions affect the sound? Ask questions and do not accept misdirects for answers.

ANJOU interconnects are specifically designed to address all of the issues listed above. Conductor spacing, insulation spacing, and general alignment are all held to tight tolerances. It would not be possible to do without machinery.

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Profile of Pear Cable Incorporated

Pear Cable is a high fidelity audio company focused on delivering the finest audio cable products in the world. The purity of the sound transferred by Pear Cables is unrivaled. We firmly believe that being anything less than the best is simply not acceptable.

Sound systems available today have the capability of reproducing sound with precision that was simply unattainable 10 years ago. Advances in materials, design theory, and manufacturing quality, have all come together to enable this revolution. As with many physical systems, in audio, the weakest link will limit the performance of the entire system. As many people have come to realize, cables are often that weak link, becoming the most problematic and sound damaging aspect of an otherwise high quality audio system.

Cable design is inherently fraught with compromises. Correcting one problem can easily lead to the worsening of another. At Pear Cable, we believe that this has caused the majority of existing cable companies to essentially throw in the towel and settle for cable designs that “color” the sound in a manner that they feel is pleasing. This is the reason why different people prefer different cables. While there is nothing wrong with listening to music through what is effectively a filter, it is our firm belief that it is difficult to compete with the sonic neutrality that Pear Cables strive to achieve.

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