# Magnetic Tape Construction

**Magnetic tape construction consists of a thin binder layer comprised of iron oxide or metal particles that records the magnetic signal and is supported by a thicker film backing or substrate. The magnetic layer (or top coat) consists of magnetic particles suspended in a polymer binder. The binder holds the magnetic particles in place, and binds them to the substrate layer. The binder layer which also contains the magnetic particles, is the layer that is in contact with the drum and rotating heads. The top binder coat records and stores the magnetic signals written to it, and its composition partly determines the frequency response, sensitivity, distortion, and inherent signal-to-noise ratio.**

**The binder also contains a lubricant as well as carbon black to minimize static buildup that would attract debris. A head cleaning agent is also impregnated into the binder to reduce head clogs... As you might have guessed by now, the binder layer of the tape is the most critical layer, as well as the most complex.**

**The binder, since it contains the magnetic oxide or metal particles, must be thin enough to allow close proximity to the rotating heads. Thus the binder by itself, hasn't the necessary strength to give the tape durability or dimensional stability. To give the tape strength, the binder is bonded to a thicker substrate. Finally a smooth back coat layer is usually applied to the backside of the substrate. This smooth back coat reduces friction, minimizes static buildup and provides a smooth stable base for the overlying wraps.**

**Unfortunately, the magnetic oxide/particles, binder and backing are all potential problems...**

**Degradation of the binder occurs whether or not the tape has ever even been used or recorded on. Normal humidity in the air seeps in to the binder and weakens it's physical characteristics - a process known as hydrolysis (bad analogy, but much like soaking the labels off of a glass bottle). When this occurs (it's just a matter of time), the binder delaminates from the substrate and turns into (for lack of a better technical term) a gooey sticky mess. The phenomenon is known as "Sticky Tape Syndrome"..... The sticky broken pieces of binder & its' suspended magnetic oxides, clog the heads or literally delaminate and fall off if ignored too long, making playback impossible. The now sticky tape will not slide smoothly over the guide posts and head drum, but will stick - bind and literally audibly squeal in protest. In severe cases it will stick so bad that tape motion is brought to a grinding halt, as it binds up around the head drum or wraps itself in a tangled gooey mess around the capstan and jams up tight.. So high can be the tension that in some cases the video heads can chip from the forces of the pinched tape and sometimes mangled tape, turning your VCR into a glorified pile of junk. (wonderful, huh ?)**

**Closely related to the sticking problem is the lubricating agent impregnated into the binder layer when the tape was manufactured. Over time and repeated plays, that lubrication is slowly lost..... again resulting in excessive friction.**

**The binder and substrate are also susceptible to breakdown by exposure to heat as well as ultraviolet light. Many older tapes have had a "hard life" !**

**Being not much more than a glorified long flexible magnet, videotape by its' very nature, is susceptible to stray magnetic fields. Like any magnet, over a period of time, the magnetic molecules lose their polarity (slowly self demagnetize). This is influenced to a very small degree by earth's magnetic field itself. More significantly, the tape transport also becomes magnetized over time. Like audio recorders, video recorders should be de-magnetized as part of a standard maintenance program. Other than in the broadcast industry, no one I know of ever does, and each pass of a videotape in a magnetized vcr does more damage, as the effects are accumulative.**

**Serious damage is quickly done by exposure to much stronger stray fields such as accidentally placing the tape in close proximity to a large speaker which has a strong voice coil magnet. Even properly stored, the tape will slowly demagnetize over a period of years. When this occurs, the signal to noise ratio falls and the video appears noisy with washed out colors, and lacks high frequency detail.**

**So even in the best storage environment and never played, the videotape is ultimately doomed.**

## If all this isn't enough, the tape must endure physical punishment

**Other than somewhat degraded video quality, tapes less than 5 years old will usually play with little trouble, but a lot depends on the quality of the tape and shell housing, how it was stored, how many times it was previously played, whether it was periodically re-packed & re-tensioned and how gently the vcr handled it.**

**Most home Vcr's are hard on tapes. The tape transports are not particularly sophisticated and can easily stretch, scrape and distort the tape. Instead of guidepost roller bearings, most consumer machines have fixed guideposts where the tape just drags over the the posts. Vcr pinch rollers (the rubber rollers that pinch up against the capstan to pull the tape out of the cassette and thru the transport) don't last forever. A bad pinch roller is a common problem, as no one ever seems to replace them. When the rubber gets old, brittle and distorted, they skew the tape unevenly; forcing it into the upper or lower stops of the guide posts. This curls the video tape and causes extreme wear on the tape edges. Since the control track pulses are usually written towards the outside edge on most vintage formats and the tape is now physically distorted, the servo system begins to mis-track. The distortion usually isn't uniform and the "auto-trac" functions on new vcr's can't keep up. The end result: the tape is mis-positioned for the next field and the scanning heads aren't scanning down the middle of the video tracks, but instead end up in the guard band. You end up with tracking noise in the video, or in severe cases no video at all if you have a newer model vcr that blanks the video if adequate signal strength is lost. The resulting physical damage to the tape due to a faulty pinch roller, is accumulative.**

**Cassette table height adjustment is critical. To high or too low, and the tape binds in the entry & exit guideposts resulting in more tape damage. Unfortunately, it's also a common problem.**

**Sometimes the damage is done by the cassette itself. For years, a well recognized manufacturer's VHS cassettes was notorious for poorly polished entry/exit guide posts in the cassette shell itself. Several rewinds and they'd leave a nice deep scratch down the length of the tape resulting in a horizontal noise line in the video. Most inexpensive (read: cheap) cassettes also lack highly polished guideposts resulting in excessive wear each time the tape is used.**

**The environmental conditions in which the tapes are stored plays a major role in the long term dimensional stability of the tape. It takes very little hardly perceivable warpage or stretching, to wreak havoc on trying to achieve a stable playback. After many years, the dimensional stability of the tapes degrade and the tape starts to deform, depending on the internal stresses on the wraps of tape. These varying stresses are due to uneven moisture absorption/evaporation causing the tape to swell or contract unevenly with the varying trapped humidity between the wraps. Over the years, the tapes "stretch & twist" plus expand & contract, in an attempt to even out the internal stresses. Unfortunately, the deformities are not a constant, which often results in widely swinging tracking errors on playback.... A "penetrating glimpse of the obvious" perhaps, but the longer the pent up forces have to act, the greater will be the deformity. Sadly, many vintage tapes haven't been re-tensioned in over 30 years. This is the reason that it is widely recommended that any tape (either reel or cassette based) be fast-forwarded and rewound at least once every three years to**

**relieve any internally built up stresses on the tape). Some tapes suffer serious dimensional aberrations due to never being re-packed, while others for various esoteric reasons, survive completely unscathed.**

**Older tapes in particular should never be put into pause, still frame or even slo-motion modes. If the tape isn't moving, the heads constantly spin over just one area of the tape. Still framing an old tape will often grind right down into the soft weakened binder - destroying that area and inevitably clogging the heads. If you're going to play an old tape, then keep it moving ! ..... (Somewhat akin to driving in snow I suppose..... if you stop, you'll probably get "stuck" !)**

**Given all this, it's almost amazing that tapes last as long as they do.....**