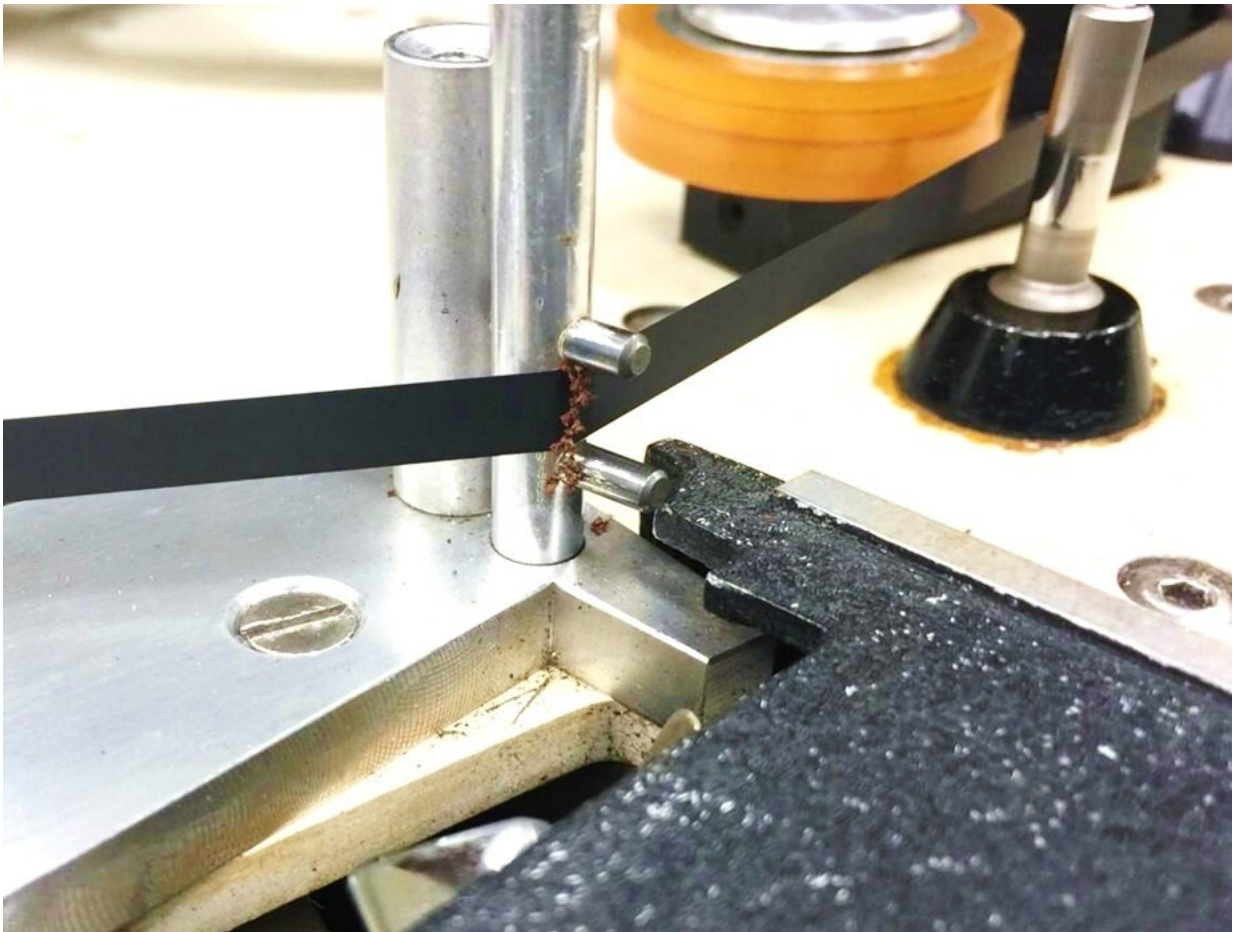


Unwinding the mystery of degraded reel-to-reel tapes

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A brown "sticky shed" residue on an unplayable reel-to-reel tape is shown accumulating at a playback machine's contact points; the residue disappears upon heating. Credit: Andrew R. Davis

Crooner Bing Crosby knew a thing or two about sound. In 1947, recognizing that recorded music sounded better on magnetic reel-to-reel tape than on vinyl records, he invested in a company to develop equipment to record his radio shows. Soon, reel-to-reel tapes and recording and playback machines were a household craze. Now, as reel-to-reel tapes make a comeback among audio buffs, scientists are unraveling the secret of why some decades-old tapes are unplayable, while others retain their original superb audio fidelity.

The researchers are presenting [their results](#) through the American Chemical Society (ACS) SciMeetings online platform.

"It is a mystery why some tapes hold up and others don't," says Andrew R. Davis, Ph.D. "I talked to audio technicians to ask what they do to remedy unplayable tapes. They knew that heating degraded tapes worked, and they used everything from toaster ovens to hair dryers. But no one knew exactly why heat worked, and sometimes the tapes reverted quickly to being unplayable. We are trying to find out why."

The project is of special interest to Davis, a polymer chemist at the Library of Congress (LC), which has nearly 200,000 reels of audio tapes spanning recordings of popular musicians, National Public Radio (NPR) broadcast archives and the American Folklife Center. The collections are used by scholars and documentary producers around the world. Universities, private citizens and museums also have aging reel-to-reel tapes, and Davis emphasizes that his work could help them preserve recordings in their collections, as well.

Reel-to-reel tapes are generally comprised of a multilayer polyester-urethane polymer containing various additives and lubricants. Tapes that degrade often have "sticky-shed syndrome," which is created by the deterioration of binders in a [magnetic tape](#) that hold the [iron oxide](#) magnetizable coating to its plastic carrier or that hold the thinner back-

coating on the outside of the tape. Sticky-shed syndrome leaves a residue that can damage the tape and playback equipment.

The [sweet spot](#) for thermal treatment of tapes appears to be around 130°F, Davis says. In his studies, Davis used sample tapes from LC's analytical lab that are representative of the library's valuable collections. On most of the tapes he studied, he observed that residues on the surface of the binder layer were crystalline and polyester-like. He also found that these residues melted back into the bulk polymer layer upon heating, turning an unplayable tape into a playable one. It turns out that the crystals re-appear, or bloom, on the tape surface when they become unplayable again. His studies of thermal transitions in the magnetic layer and polyethylene terephthalate support film indicate that a single component does not account for tape degradation and that the detrimental residues are not isolated to the tape binder layer.

"This research also confirmed what we heard from audio technicians, that thermally treated tapes that were wound on reels reverted to a visibly deteriorated condition within a few weeks," Davis says.

"Surprisingly, we found that when our small unwound test samples of tape were thermally treated, they appeared to be optically fine even after weeks. Clearly being wound has some effect on the tapes."

"One explanation is that when you bake and melt the tape residues, they transfer to the backside of the adjacent, nonmagnetic layer of tape. As it cools down, it retransfers to the oxide layer if the tape is tightly wound," Davis says. "Or perhaps the pressure of winding the reel has something to do with the melting and recrystallization process." Davis and his colleagues are studying those possibilities now.

Despite the ongoing mystery, Davis has advice for people who love their stashes of reel-to-reel tapes and want to know how to store or restore their old tapes. "The best bet is to buy a good technical oven to control

the temperature of restoration and good playback equipment, rather than highly specific environmental controls," he says. "You probably wouldn't want to store your tapes in a sauna, but normal seasonal changes in temperature and humidity seem to bode well for [tape](#) storage."

Provided by American Chemical Society

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