

## **KODAK Ultima Lifetime Discussion**

The KODAK Ultima CD-R disc is fundamentally the same as the Gold Ultima CD-R media except the reflective layer material is changed. The Ultima disc incorporates an alloy containing 24 karat gold which has been selected to provide maximum performance, as well as improved stability relative to pure silver. Media recording and playback performance is comparable to Gold Ultima, and in fact, enhanced compatibility has been found with the Ultima CD-R.

### **Ultima Stability**

The CD-R industry has been offering customers the option of purchasing media with a silver reflective layer in place of the traditional gold layer. This has been done for a number of reasons including increased reflectivity of the reflective layer, a disc appearance similar to CD-ROM, and reduced manufacturing costs. Customers are aware that everyday silver-based products (jewelry, silverware, coins etc.) can oxidize and tarnish over time. For this reason, there has been some skepticism about the stability of the new silver-based CD-R discs. Kodak has shared these concerns, and has opted not to offer a 100% silver-based CD-R product. We have found that by using a stable gold alloy, the lifetime of the CD-R media can be significantly enhanced.

The data life of storage media is a key consideration of customers. It is also one of the most difficult parameters to measure, and consequently one of the most misunderstood and misleading parameters to be reported. By necessity, data lifetime must be tested under accelerated aging conditions which are well outside normal storage conditions. These results must then be used to project an anticipated lifetime at actual storage conditions. The key problem is how this projection is to be made.

Estimating media life would be difficult enough if lifetime depended only on temperature. Unfortunately, humidity also plays a significant role. Atmospheric pollutants could also have an effect, but due to the encapsulation of the recording layers in a

polycarbonate/lacquer package this is considered a low risk, and is usually ignored. During the early stages of evaluation, it is common practice to select a single stressful condition which is known to cause media failure within a manageable time span of several weeks. In the case of silver-based CD-R media Kodak has selected a condition which is quite extreme, consisting of a temperature of 80°C, a relative humidity of 85%, and an atmosphere of local air (which will contain some of the aforementioned pollutants). We then assume that the longer the media survives under these conditions, the more stable discs will be under recommended storage conditions (25°C, 40%RH).

We have tested other manufacturers' 100% silver media as well as our own Ultima media under these conditions. The results are summarized in Table 1.

<b>Manufacturer</b>	<b>80/85 Survival Time</b>	<b>Cause of Failure<sup>1</sup></b>
Kodak Ultima	> 3 weeks	none yet
Company A	<1 week	extensive corrosion
Company B	<1 week	overall reticulation
Company C	<1 week	package delamination
Company D	<3 weeks	blisters
Company E	<3 weeks	patchy corrosion
Company F	<3 weeks	contrast loss

Table 1. 80/85 survival times for various manufacturers' silver CD-R media

These survival times cannot, by themselves, be used to predict the lifetime of data on discs stored at recommended conditions, but they are a good indicator on a relative basis.

Accurate lifetime estimates require extensive testing over many months, at a variety of temperature and humidity conditions, and using a statistical population of discs. The test plan which was utilized to predict lifetime for Kodak's Gold Ultima media required over 210 discs, stored at 5 different temperature-humidity conditions, and tested for performance on over 40 separate occasions over the course of more than one year.

<sup>1</sup> Failure was considered to be the time at which the maximum BLER (block error rate) on a fully recorded disc exceeded 50.

At this time, survival tests at (80°C, 85%RH) have been conducted on silver-based CD-R media. We have found that using 100% silver for the reflective layer produced media which failed in less than 1 week and with failure highly dependent on the small variations in the coating process conditions.

In the case of our Ultima reflective layer, our standard coating conditions were able to produce media with a superior survival time (in excess of 3 weeks at 80°C, 85%RH). We have demonstrated that the Ultima reflective layer is both stable and robust because it is resistant to small, but expected variations, in the coating process.

The robust manufacturing process demonstrated with the gold alloy will provide users of KODAK's Ultima media with an additional degree of confidence that they are receiving a high performance and uniformly stable product.

# Product Performance Specifications

KODAK Ultima CD-R media will meet the same specifications as KODAK Gold Ultima CD-R media product. Some critical specifications for the Ultima media have been measured on various speed writers and compared with specification. The results are summarized in Table 2.

Table 2 : Key parameters for Ultima CD-R media compared to specification

Parameter	Orange Book Specification	Ultima Media
<b>Stability</b>		
Shelf Light Stability	50Klux/3day	pass
Archive Light Stability	50Klux/5day	pass
<b>Unwritten</b>		
RCb	>.05	0.080 min.
PPb	none	0.107 min.
PPb var.	<+-15%	±7%
RGB	65%	72% min.
WCNRb	>35dB	39dB min.
<b>2X full surface write</b>		
Rtop	>65%	71%
I3/Itop	0.3-0.7	0.36
I11/Itop	>0.6	0.63
BLER	<220	1
<b>4X full surface write</b>		
Rtop	>65%	71%
I3/Itop	0.3-0.7	0.33
I11/Itop	>0.6	0.62
BLER	<220	1
<b>6X full surface write</b>		
Rtop	>65%	71%
I3/Itop	0.3-0.7	0.33
I11/Itop	>0.6	0.62
BLER	<220	1
<b>2X Power Series</b>		
I3/Itop @ β=0	none	0.30
I11/Itop @ β=0	none	0.64
3TMJIT @ β=0	none	31/32ns