

# Save Your Music & Photo Collection from **DISC ROT**

The physical construction of a typical pressed music CD should provide reliable performance for over 50 years according to the [Redbook specifications](#), published by Sony and Philips, which provide for quite stringent manufacturing standards for licensed factories to ensure disc playback compatibility, audio quality and longevity. However, the choice of aluminium, as an efficient but cost effective laser reflective layer, is arguably the weakest manufacturing component in the otherwise most successful format ever for the global distribution of recorded music.

With a capacity of up to 80 minutes of uncompressed high quality, 16 bit digital music programme sampled at 44,100 times per second, the potential for conveying lifelike levels of dynamics, acoustic clarity and musical accuracy has provided enormous enjoyment for music lovers worldwide for over 25 years with over 200 billion music CDs sold in that time.

Whilst many of those 200 billion pressed music CD's will meet the specified longevity expectations, a significant number, possibly in the order of 10-25%, could succumb to **disc rot**, also known as laser rot, which is the breakdown of the aluminium laser reflective layer due to the easy reaction of aluminium with the commonly encountered threats of oxygen, ozone, sulphur traces and some ions in condensed water vapour. Whilst aluminium oxide passivation offers some resistance this is often compromised by the disc's extremely thin lacquer protective layer, the thickness of which is not always uniformly even due to irregularities in coating during manufacturing. Lacquer coatings that are below thickness specifications are also more vulnerable to scratching or cracking when discs are flexed during removal from jewel cases.

The recordable CD (CD-R) as described in the Sony and Philips Orange Book specifications, has also enjoyed enormous popularity with consumers worldwide with many billions of CD-R discs manufactured since 1992. The CD-R format was initially embraced as a mastering and reference digital audio recording format by broadcasters, music studios, record companies and archives, but quickly gained enthusiastic support from photographers after Eastman Kodak showed the way with the jpeg based *Kodak Photo CD* in 1993.



Photo 1: Pressed music CD from 1987 displaying severe disc rot.

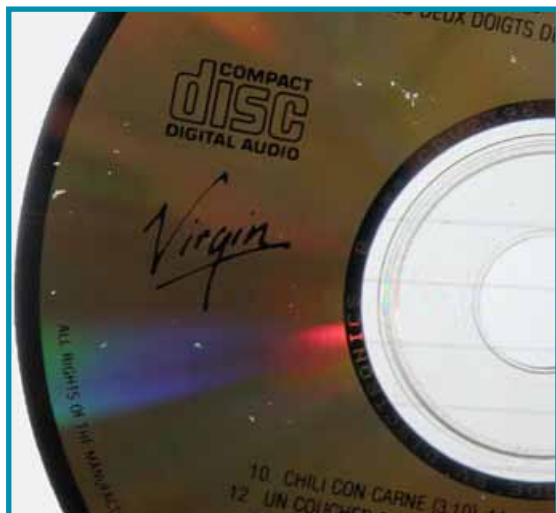


Photo 2: Pressed music CD (1986) displaying multiple pin holes in aluminium reflective layer.

As with the pressed CD, the CD-R format also employs a metallic alloy laser reflective layer together with an additional laser recordable layer. The laser recordable layer is manufactured from various organic dye chemicals which, when exposed to a high power recording laser, help form a pit structure representing a physical data map of any digital music, photographs or video content selected for recording. However, both of these layers can also be susceptible to early physical breakdown. This is due to a combination of reflective layer **disc rot** and recording layer dye failure if not manufactured with the highest quality components and standards.

The onset of **disc rot** oxidation (rusting) can, over a period of time, lead to a complete disruption of the optical laser beam containing the music recording signal. Elevated temperature and humidity are also likely to accelerate the oxidation of the aluminium or metallic alloy reflective layer; with even higher risks when exposed to recurring, rapid temperature and humidity swings of above 20° Celsius and 40% relative humidity respectively. The professional archive community have generally agreed that the ideal archival storage conditions for both pressed and recordable optical discs are a constant 18° Celsius and 30% relative humidity.

Photographs stored as JPEG, TIFF and other digital file formats on the mostly commodity grade CD-R discs commonly supplied by photo labs and other retail outlets, are also susceptible to **disc rot** due to the use of various cheaper silver alloys in the CD-R reflective layer. These silver alloys generally provide some improvement in quality and longevity when compared with aluminium, but corrosion can still occur as oxidation of the weakened silver alloy matrix commences –the only pure metal to be completely unaffected by air, moisture and most corrosive reagents is **24 karat gold**.

Another reliability concern with these commodity type cyanine and azo based CD-R discs is their susceptibility to loss of recorded information due to the fading of the recording dye layer. It is well documented that the most common cyanine, azo and other budget dye blends are quite unstable when exposed to ultraviolet light (i.e. sunlight). Whilst the Sony and Philips Orange Book details the principal specifications for the manufacturing of recordable CD discs, the implementation of the licensing has been arguably less effective than with the Red Book, particularly with regard to ensuring quality control, reliability and longevity of the finished product – *let the buyer beware*.

Photos 1, 2 and 3 are of disc samples taken randomly from a small, personal music pressed CD collection spanning the period 1983-1994, some sourced in the United Kingdom and Europe (pre 1986) and others sourced in Australia.



Photo 3: Sample pressed music CDs showing pin holes in aluminium reflective layer affecting data/tracks. (David Sylvian, 1987 CDV 2471 and Betty Blue, 1986 CDV 2396).

As can be seen from the above photos , the oxidising of the thin aluminium reflective layer begins as tiny pin-hole size spots which can easily be observed by holding an affected disc up to any bright light source at arms length (approx 30-40cm) with the printed label (top surface) of the disc facing your eyes.

With most healthy discs, no light at all will be visible passing through any of the 12cm diameter of the disc's surface, but the presence of just one pin-hole spot is an indication that oxidation has commenced, triggering playback error correction and possible clicks, skipping, chatter, static or scrambled audio due to laser reading errors. But worse still, once oxidation has begun, the process of layer destruction can be quite rapid leading to a constellation of pin holes and the imminent catastrophic damage as seen in photo 3 above, in which case whole sections of the disc have become permanently unreadable with all content lost forever.

Of course, this simple test only indicates **disc rot** symptoms visible to the naked eye, whilst many other discs may have microscopic pin-holes not evident with casual inspection, which might still compromise playback reliability, music quality and will certainly spread as oxidation accelerates.

(Please refer to “Almost Famous” test conclusion).

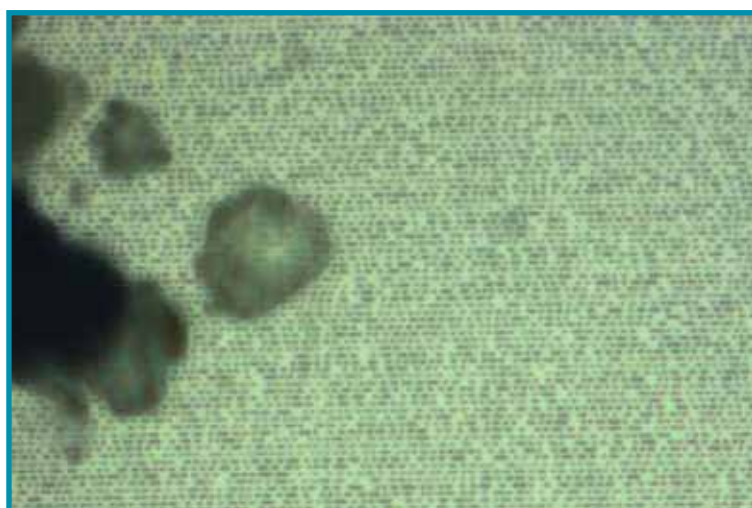


Photo 4: Close up showing effect of disc rot on the pits and lands of the CD data tracks.



Photo 5: Close up of damage in pressed aluminium reflective layer.

## **PRODISC** 24 Karat Gold

- *99.99% purity gold leaf foil reflective layer*
- *Completely inert, non-oxidising, corrosion proof*
- *Extremely uniform reflective coating*
- *Soft, super smooth finish without pin holes*
- *Most accurate laser reading surface*
- *Constant rate of reflection over disc*
- *Extended audio frequency response*
- *Improved stereo imaging*
- *Better instrument separation*
- *High frequency spatial detail*
- *Vocal and mid-band clarity*

## **PRODISC** Phthalocyanine

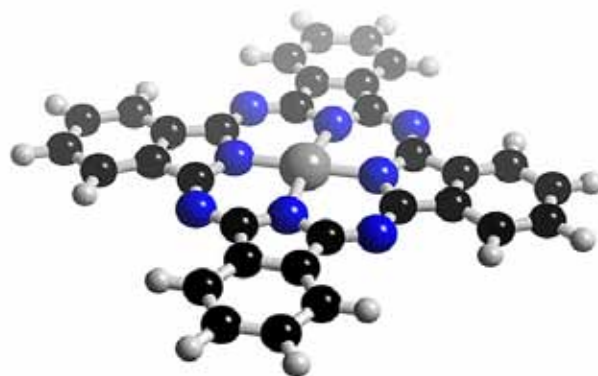
- *Patented Mitsui laser recording layer*
- *Licensed Mitsui manufacturing*
- *Pure Mitsui fade-proof formulation*
- *Ultraviolet resistant*
- *Longest lifetime of any recordable dye*
- *Robust annular molecular structure*
- *Rapid pit burning (“burst mode”) ensures pit accuracy*
- *Ideal for lower speed recording*
- *Precise well defined pits ensure low jitter and C1 errors*
- *High transparency ensures recorder and playback compatibility*

In some cases, a replacement pressed music disc can be sourced, if still available, but many record labels' inventories are limited at best. If a replacement is not viable, another solution is to conduct a survey of your music CD collection over time and identify and isolate any discs displaying early **disc rot** symptoms in readiness for precautionary lossless-transfer (backup copying) to **PRODISC** Archival Gold CD-R which will reliably preserve any music or photo disc for up to 100-300 years (depending on storage and handling conditions).

However, if the affected disc is a photo CD-R disc recorded with precious family photographic memories, the outcome of ignoring the symptoms could be partial or complete loss of the photographs on that disc -- immediate transfer of any affected discs should be completed as soon as possible.

Please note that digital transfers (backup copying) of your own personal music CD collection are entirely legal and in accordance with new copyright law: “... changes to the law commencing January 2007 allow copying of sound recordings for personal domestic use in certain situations... You can only create copies of legitimately acquired CDs for your own private and domestic use to play on another CD player that you own... You can, however, lend copies you have made to members of your family and household.”

For details please visit the [Music Industry Piracy Investigation website](#).

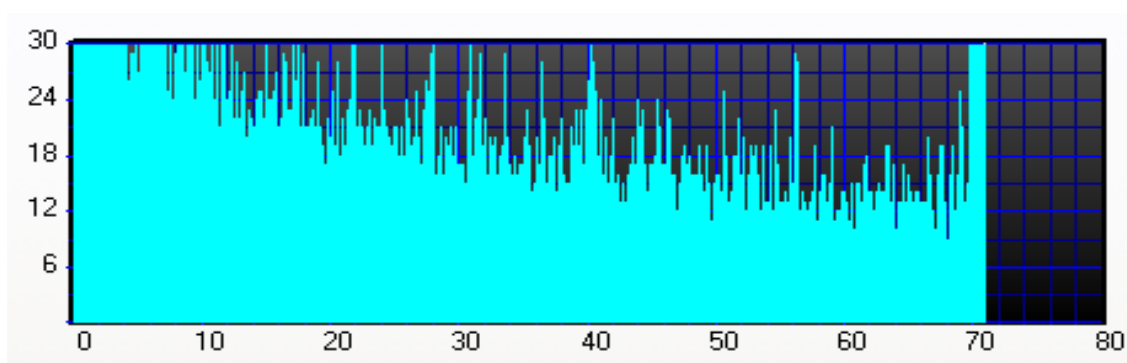


**Phthalocyanine molecular structure**

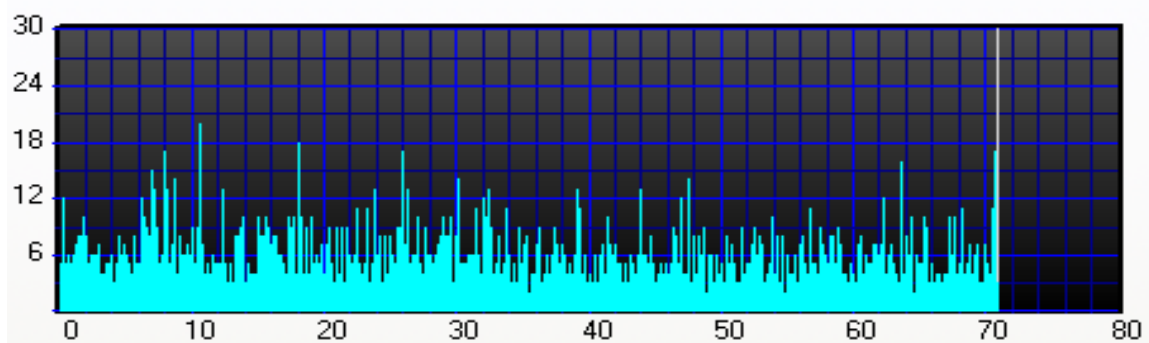
The significant improvement in the stability of **PRODISC** Archival Gold copies is due to the corrosion proof, pure 24 karat gold **PRODISC** reflective layer and phthalocyanine fade proof **PRODISC** recording layer exclusively employed in all **PRODISC Australia** Archival Gold CD-R products since 1995. Together with displaying great longevity and stability, the preserved **PRODISC** Archival Gold CD-R copy will also benefit from optical improvements in error counts (BLER, C1, C2 errors etc) and jitter (timing errors) allowing more faithful playback of music content and more accurate location of individual photographs on photo discs.

Sample analysis reports and quality checks of such digital transfer procedures conducted recently, show comparisons between **PRODISC** Archival Gold copies of two original pressed CDs: An 8 year-old often played regular aluminium pressed CD of the movie soundtrack of “Almost Famous” (January 2001) and a brand new and recently released Santana “Abraxas” audiophile pressed gold CD (March 2008); both were tested (scanned) for various manufacturing errors, jitter and wear-and-tear errors, and then digitally transferred to the following **PRODISC** Archival Gold discs at various record speeds: **PRODISC Reference Archive Gold CD-R @** medium and high speeds and **PRODISC Audio Master Gold CD-R @** low speeds. **All** test copies were recorded in a Plextor Plexwriter Premium 2 CD writer drive. All disc scans were conducted with two different scanning drives and two different disc quality testing programmes for cross referencing.

“Almost Famous” (2001) sample error graph (NERO DiscSpeed) for **original pressed aluminium CD**:



“Almost Famous” (2001) sample error graph (NERO DiscSpeed) for **archival copy on PRODISC Audio Master Gold CD-R 74**:



## Title A: "Almost Famous"



2001 original aluminium pressed CD

CAT No: 450279-2

### Test Series 1: (Nero)

Scanned with BenQ DVD LSDW 1655 DVD drive (CD/DVD writer)

Tested with Nero DISCSPEED software @ 8x constant linear velocity (CLV)

Test Title	Type	Test Sample	Record Speed	Advanced Quality Test								Standard Quality Test				Rank
				E31 Errors Max/sec	E31 Errors Total	E22 Errors Max/sec	E22 Errors Total	BLER Errors Max/sec	BLER Errors Total	E32 Errors Max/sec	E32 Errors Total	Jitter Max%	Jitter Av %	Class	Quality Score	
Almost Famous	Copy	<b>PDISC AMG74</b>	8x	6.0	63	0	0	21	9775	0	0	7.4	7.0	2	97	1
Almost Famous	Copy	<b>PDISC RAG80</b>	48x	10.0	438	0	0	20	11807	0	0	12.0	8.6	2	97	2
Almost Famous	Copy	<b>PDISC RAG74</b>	32x	15.0	275	0	0	24	14396	0	0	11.0	7.2	2	96	3
Almost Famous	Original	Pressed Aluminium CD	N/A	152.0	5,533	235	6541	327	76132	361	6172	8.2	7.0	5	0	4

**Key:**

**PDISC AMG74 : PRODISC AUDIO MASTER GOLD CD-R 74**

**PDISC RAG80 : PRODISC REFERENCE ARCHIVE GOLD CD-R 80**

**PDISC RAG74 : PRODISC REFERENCE ARCHIVE GOLD CD-R 74**

### Test Series 2: (Plextools)

Scanned with Plextor PREM 2 CD drive (CD writer)

Tested with Plextools V2.33 software @ 4x constant linear velocity (CLV)

Test Title	Type	Test Sample	Record Speed	C1 / C2 / Jitter Test										Rank		
				C1 Errors Max/sec	C1 Errors Av/sec	C1 Errors Total	C2 Error Max/sec	C2 Errors Av/sec	C2 Errors Total	CU Errors Max/sec	CU Errors Av/sec	CU Errors Total	Jitter Max%		Jitter Av %	
Almost Famous	Copy	<b>PDISC AMG74</b>	8x	19.0	1.7	7,313	0	0	0	0	0	0	0	12.0	9.2	1
Almost Famous	Copy	<b>PDISC RAG80</b>	48x	20.0	2.1	8,983	0	0	0	0	0	0	0	11.8	7.9	2
Almost Famous	Copy	<b>PDISC RAG74</b>	32x	21.0	2.9	12,362	0	0	0	0	0	0	0	13.2	9.5	3
Almost Famous	Original	Pressed Aluminium CD	N/A	254.0	16.1	68,838	188	0.8	3,286	217	0.6	2,624	14.0	10.0	4	

**Key:**

**PDISC AMG74 : PRODISC AUDIO MASTER GOLD CD-R 74**

**PDISC RAG80 : PRODISC REFERENCE ARCHIVE GOLD CD-R 80**

**PDISC RAG74 : PRODISC REFERENCE ARCHIVE GOLD CD-R 74**

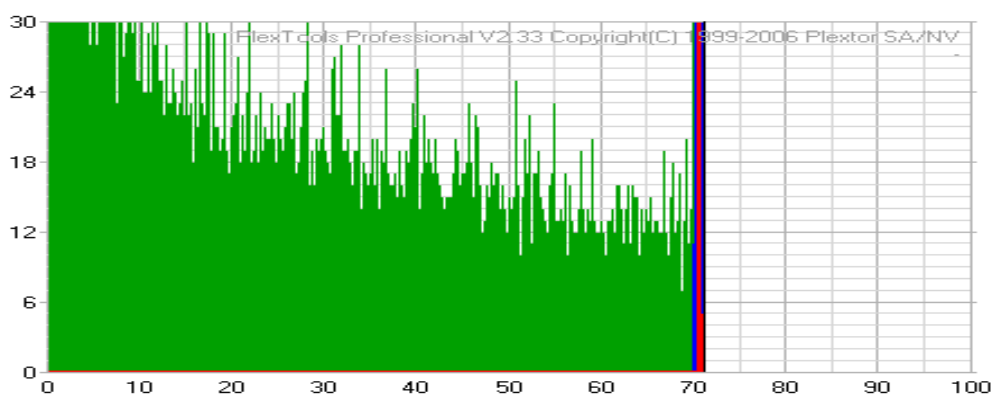
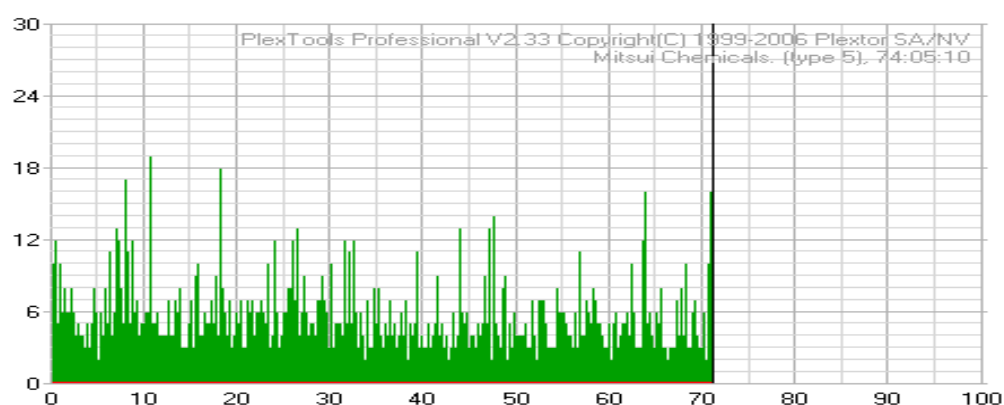
Please refer to "Test Graphs and Glossary" PDF attached for detailed information

**“Almost Famous” Test Conclusion:**

Despite inspection with the naked eye indicating no evidence of any pin holes, disc rot or major handling damage, this pressed CD displayed considerable error counts when tested. The **PRODISC** Archival Gold copies all show excellent low error and controlled jitter performance, quite an achievement given that the original pressed CD displays error counts into the many tens of thousands, including a considerable number of higher order errors.

The use of low priced, general purpose or data grade CD-R for music archiving is extremely unwise due to the unstable nature of the budget quality manufacturing components and accelerated price driven production cycles. Such products are generally suitable for short term storage or data transfer, but for precious music and photo CD collections, the only Australian and New Zealand government archive proven solution is the **PRODISC** Archival Gold range, due to the scientifically proven, very long term stability of the critical 24 karat gold reflective layer and phthalocyanine recording layer.

General purpose, data grade CD-R might, or might not provide *initial* acceptable error and jitter counts, but due to the instability of the cyanine, azo and other blends of recording layer chemistry employed by most other manufacturers, those counts will multiply quite rapidly over time due to the impact of ultraviolet light (sunshine), elevated temperature, humidity and day to day handling.

**“Almost Famous (2001) sample error graph (Plextools) for original pressed aluminium CD****“Almost Famous” sample error graph (Plextools) for archival copy on **PRODISC** Audio Master Gold CD-R 74**

## Title B: "Abraxas"



2008 original gold pressed CD

Mobile Fidelity Audiophile Ultradisc, 24 Karat Gold

S/N: 05019 SKU: UDCD775

### Test Series 1: (Nero)

Scanned with BenQ DVD LSDW 1655 DVD drive (CD/DVD writer)

Tested with Nero DISCSPEED software @ 8x constant linear velocity (CLV)

Advanced Quality Test													Standard Quality Test			
Test Title	Type	Test Sample	Record Speed	E31 Errors Max/sec	E31 Errors Total	E22 Errors Max/sec	E22 Errors Total	BLER Errors Max/sec	BLER Errors Total	E32 Errors Max/sec	E32 Errors Total	Jitter Max%	Jitter Av %	Class	Quality Score	Rank
Abraxas	Copy	<b>PDISC AMG74</b>	2x	9.0	18	0	0	18	5583	0	0	11.0	7.3	2	97	1
Abraxas	Copy	<b>PDISC RAG80</b>	52x	15.0	328	0	0	21	6614	0	0	11.3	8.5	2	97	2
Abraxas	Copy	<b>PDISC RAG74</b>	16x	23.0	218	0	0	28	6639	0	0	9.0	7.1	2	96	3
Abraxas	Original	Pressed Gold CD	N/A	18.0	279	0	0	40	16617	0	0	9.8	8.0	2	95	4

**Key:**

**PDISC AMG74 : PRODISC AUDIO MASTER GOLD CD-R 74**

**PDISC RAG80 : PRODISC REFERENCE ARCHIVE GOLD CD-R 80**

**PDISC RAG74 : PRODISC REFERENCE ARCHIVE GOLD CD-R 74**

### Test Series 2: (Plextools)

Scanned with Plextor PREM 2 CD drive (CD writer)

Tested with Plextools V2.33 software @ 4x constant linear velocity (CLV)

C1 / C2 / Jitter Test															
Test Title	Type	Test Sample	Record Speed	C1 Errors Max/sec	C1 Errors Av/sec	C1 Errors Total	C2 Error Max/sec	C2 Errors Av/sec	C2 Errors Total	CU Errors Max/sec	CU Errors Av/sec	CU Errors Total	Jitter Max%	Jitter Av %	Rank
Abraxas	Copy	<b>PDISC AMG74</b>	2x	15.0	1.8	3,992	0	0	0	0	0	0	11.7	8.8	1
Abraxas	Copy	<b>PDISC RAG80</b>	52x	20.0	2.1	4,829	0	0	0	0	0	0	9.2	6.5	2
Abraxas	Copy	<b>PDISC RAG74</b>	16x	27.0	2.2	4,940	0	0	0	0	0	0	9.1	7.2	3
Abraxas	Original	Pressed Gold CD	N/A	28.0	4.0	9,081	0	0	0	0	0	0	10.9	8.9	4

**Key:**

**PDISC AMG74 : PRODISC AUDIO MASTER GOLD CD-R 74**

**PDISC RAG80 : PRODISC REFERENCE ARCHIVE GOLD CD-R 80**

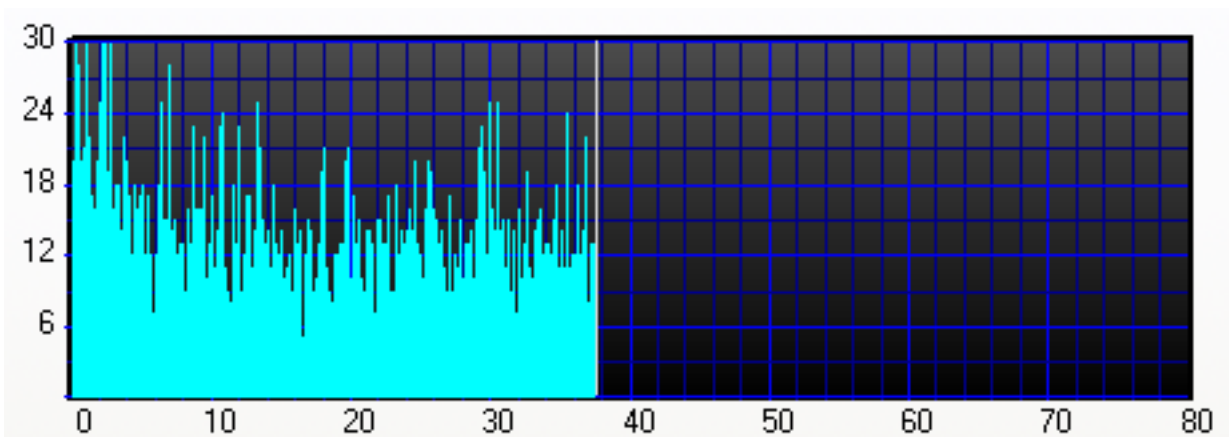
**PDISC RAG74 : PRODISC REFERENCE ARCHIVE GOLD CD-R 74**

Please refer to "Test Graphs and Glossary" PDF attached for detailed information

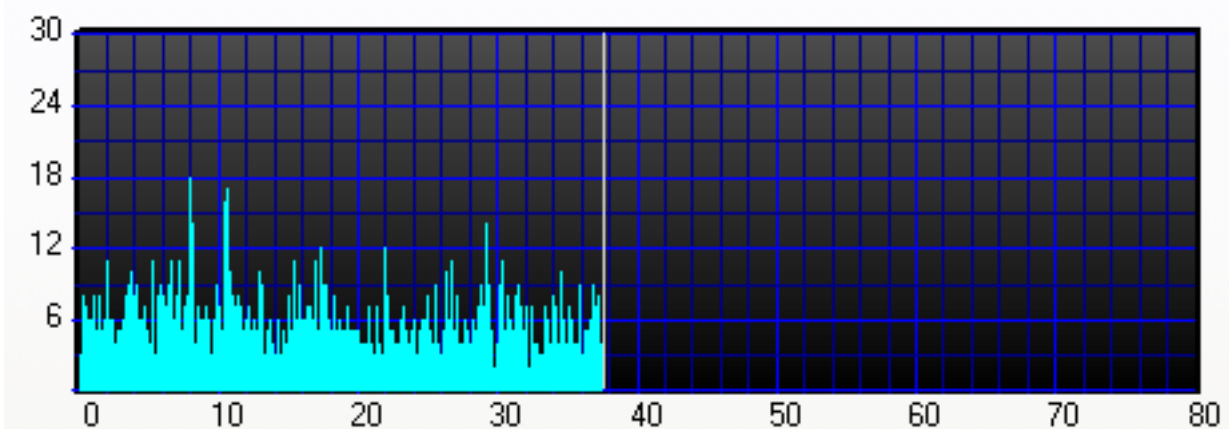
**“Abraxas” Test Conclusion:**

As can be seen from the test summary table, a noticeable technical improvement can be achieved in optical performance even over the very high quality original audiophile pressed Gold Santana CD when transferred to any of the **PRODISC** Archival Gold CD-R discs —many audiophile reviewers, industry professionals, studio and archive managers have associated these technical improvements with a perceived subjective increase in the sound quality of the **PRODISC** Archival Gold CD-R copies, particularly in the clarity of the mid-band and spatial detail in the upper frequencies.

“Abraxas” (2008) sample error graph (Plextools) for **original pressed gold CD**



“Abraxas” (2008) sample error graph (Plextools) for **archival copy on PRODISC Audio Master Gold CD-R 74**



Another recently popular practice is the transfer of music CD collections to home computer hosted hard drives or proprietary (hard drive equipped) home entertainment servers. At the time of transfer some collectors also opt for the use of lossy and destructive data compression (i.e. MP3) which permanently renders music collections compromised with unpleasant sonic and performance artefacts. For another opinion on MP3 artefacts please visit [george.massenburg.com.au](http://george.massenburg.com.au) .

Be also aware of the potentially short lifetime of computer hard drives. Most hard drive manufacturers now only offer warranties for a maximum of 3 years which, for those choosing to store precious music and photo collections or other data permanently on hard drives or home entertainment servers, calls for a contingency back-up strategy in anticipation of hard drive malfunction or virus threat. Hard drive back up and data recovery procedures for music and photographic files can be time consuming and expensive, and of course requires hosting by a computer operating system rather than a quality standalone CD or DVD player with reliable random access.

Managing the decay risk of an established family collection of music and photo CD's need not be an expensive or labour intensive procedure, with most home computers being equipped with quite adequate CD or DVD recording drives and software suitable for recording **PRODISC** Archive Gold recordable discs. Monitoring and preserving discs displaying **disc rot** symptoms on a periodic basis will reliably ensure the integrity of any collection for generations to come.



For high volume secure uncompressed storage of music content, many major archiving, broadcast and media organisations also employ **PRODISC** 'Data Seal' Archive Gold DVD-R 4.7 discs. These discs can safely store recordings of native uncompressed wav or broadcast wav files, which can be extracted very easily from any music CD. These extractions can be achieved whilst maintaining excellent fidelity to the original recording with well over 100 average duration tracks fitting onto one **PRODISC** 'Data Seal' Archive Gold DVD-R 4.7 disc.

**PRODISC Systems Australia** has for many years, supplied the **PRODISC** Archival Gold range of CD-R/DVD-R products to many of Australia's and New Zealand's leading government archives, libraries, broadcasters, studios, cultural, and scientific organisations with ongoing independent quality and longevity testing at the National Library of Australia and other archival facilities. Almost 2 million **PRODISC** archive quality recordable discs have now been preserved in major Australian, New Zealand and other regional archives without failure over 15 years —no other brand of recordable media has successfully survived such archival performance scrutiny.

Additional supporting articles:

*“Stop the Rot” - Australian Personal Computer Magazine*

*“Beware the Fading Dye” - The Wall Street Journal*

Stocks of retail sealed bulk packs of **PRODISC** Archival Gold discs are available for do-it-yourself home and studio transfers at [www.prodisc.com.au](http://www.prodisc.com.au) from around \$3.50 p/unit inc. GST along with various disc packaging and storage options and disc cleaning accessories. High quality **PRODISC** reference archive transfer and audio remastering services are also available to private collectors, along with fully compatible uncompressed, **extended duration** CD audio compiles of up to 100 minutes per disc —please contact us for details.

Recorded **PRODISC** Archival Gold copies should ideally be stored in a cool, well ventilated environment with a minimum of ultraviolet light. For best performance please consider the use of the proven **PRODISC** fullsize Black Archive flexicases which are manufactured from inert archival grade black polypropylene and provide safe disc support and unbreakable flexible design.

Also available on application are quotations for supply of audiophile and archival quality custom **24 Karat pure gold CD and DVD** replication and duplication services for quantities of 50 – 100,000 discs including a wide variety of environmentally friendly, recycled paper multipanel digipaks and premium CD and DVD packaging and printing options.



For any additional technical information or advice on **PRODISC** products or services please contact our Operations Manager at [info@prodisc.com.au](mailto:info@prodisc.com.au) or by phone ph: +61 2 9016 4415 or fax: +61 2 9909 3270.

**PRODISC** Archival Gold CD-R Products links:

[\*\*PRODISC\*\* Reference Archive Gold CD-R 74](#)

[\*\*PRODISC\*\* Reference Archive Gold CD-R 80 \(please contact for availability\)](#)

[\*\*PRODISC\*\* Audio Master Gold CD-R 74](#)

**PRODISC** Archival Gold DVD-R Products links:

[\*\*PRODISC\*\* 'Data Seal' Archive Gold DVD-R 4.7](#)

**PRODISC** Disc Cleaning Accessories links:

[\*\*PRODISC\*\* Optical Microfibre Cleaning Cloth](#)

[\*\*PRODISC\*\* Optical Disc Super Duster](#)

**PRODISC** Archival Storage Products links:

[\*\*PRODISC\*\* Black Archive Cases, fullsize](#)



**PRODISC Systems Pty. Ltd.**

**PO Box 331,**

**Strawberry Hills NSW 2012**

**Ph +61 2 9016 4415 Fax: +61 2 9909 3270**

**[www.prodisc.com.au](http://www.prodisc.com.au)**