

Storing Knowledge in Gold

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1) Century approach: professional CD media for demanding applications

Both polycarbonate injection molding and photopolymerisation (2P) manufacturing processes used today in the compact-disc pressing plants allow for a massive and cheap replication of plastic CDs. These discs were designed and are perfectly suited for the consumer market, or massive dissemination of medium-lifetime information products.

However, the availability of CD-ROM, and the increasing use of the CD-Audio or CD-Video or videodisc for professional applications has extended the compact-disc market into applications with more demanding environmental conditions.

DIGIPRESS is the first company worldwide to attempt to go beyond the consumer-level specifications of compact-discs, and to propose a professional compact-disc medium for these applications.

Just as in memory chips or integrated circuits, where both consumer (plastic) and military (ceramics) versions specifications are available, DIGIPRESS is now providing ruggedized specifications compatible compact-discs, which present a better stability in presence of:

high low temperature, thermal shocks, corrosion, electromagnetic radiations, abrasion and mechanical forces.

These properties determine, among other environmental conditions, the lifetime of optical media

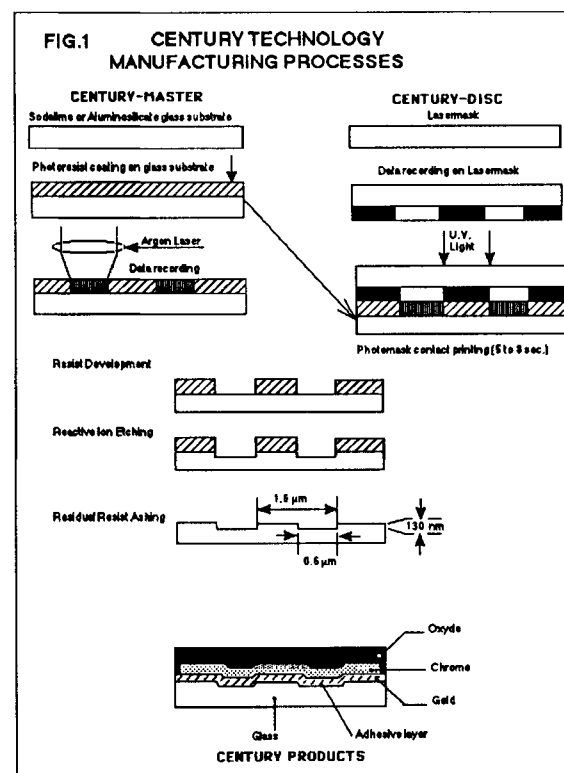
2) Century manufacturing technology

DIGIPRESS has developed a **tempered glass etching process to manufacture CD glass discs:**

- by unit (**CENTURY-MASTER™**), made by **direct reactive ion etching** of one master disc, or
- in small series, **CENTURY-DISCS™**, **replicated by a microphotolithographic contact printing process** and then etched by reactive ion etching.

Figure 1 explains both **CENTURY-MASTER™** and **CENTURY-DISC™** manufacturing processes.

The recording and development stages leaves the glass substrate surface exposed at the pit locations, while the rest of the disc is covered with resin. The glass etching process **writes the prerecorded data into the glass structure of the substrate**. Then, Century-Master™ or Century-Disc™ are coated with an adhesive layer and **metallized with 24 carat gold** (reflective layer). Protection, disc graphics and encapsulation of the disc is then realized using **metallic and refractory (ceramics or oxydes) layers without any organic component.**



3) Comparative properties of glass substrates

Several manufacturing processes and substrates are suitable for optical disc manufacturing. A brief overview of the comparative properties in these technologies shows why DIGIPRESS has come to

century technology manufacturing choices:
 Figure 2 first explains the different manufacturing processes and their related substrate materials.

Figure 3 gives a comparison between the resulting optical, mechanical, thermal and chemical properties of optical discs substrates.

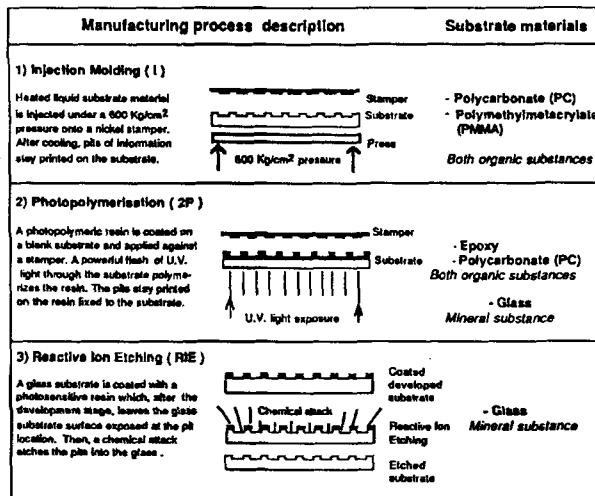


FIG 2. Materials and processes suitable for optical discs substrates manufacturing

Substrate Manufacturing Process:	PC	PMMA	EPOXY	GLASS
	I	I 2P	2P	RIE 2P
OPTICAL				
Transmission @ 630 nm	90%	93% 93%	90%	>95% >95%
Refractive Index	1.58	1.48 1.49	1.54	1.50 1.50
Birefringence (nm)	20 to 40	40 to 200 2 to 3	<1	<1 -
MECHANICAL				
Surface hardness	++	++ +	++	+++ +++
Young's Modulus	1	1 to 1.2	1.3	3,000 3,000
Modulus of rupture	1	0.7 to 1.1	0.8 to 12	> 40 > 40
TEMPERATURE				
Maximum	125 °C	90°C 125°C	90°C	400°C -
Expansion coeff. (10 ⁻⁵ /°C)	7	5 to 9	3.5 to 6.5	0.9 0.9
CHEMICAL				
Moisture absorpt.	25 %	54 %	30 %	NII NII
Expected Lifetime (worst case)	10 yrs	5 yrs 5 yrs	20 yrs	100 yrs -

(-) Not available - depends on resin type

FIG 3. Comparative properties of prerecorded optical discs substrates

4) Century products properties

4.1) Specifications

Glass substrate material (sodalime or aluminosilicate tempered glass) and Reactive Ion

Etching technology used to etch information into the glass structure give the CENTURY products their unique expected specifications, as follows:

CENTURY-MASTER™ and CENTURY-DISC™ expected SPECIFICATIONS

MEDIA: ROM type

MATERIALS: Etched tempered glass, gold, chromium, CrO₂

STANDARDIZATION: Fully compatible with CD-Audio, CD-ROM, CD-Video standards

TEMPERATURE: Permanent: - 54C to + 350C
 10mn: + 500C

Thermal shock: ΔT 200C

LIFETIME: 100 YRS

Expected: 1,000 YRS

MTBF: 1000 000 HRS

DIGIPRESS is now working with several research laboratories, archiving institutions and industrial partners testing our media. These studies should shortly demonstrate the validity of above specifications, and are actually promising higher figures.

4.2) The standardization issues

Because the materials used for the manufacturing of these discs are **minerals**, the expected **lifetime** of a Century-Master™ and/or a Century-Disc™ is **minimum a century**. This would not be meaningful if these products were not fully compatible with today's widest optical memory standards: the compact-disc physical and logical standards defined by Philips and Sony, and accepted by the international Standards Organization.

More than 70 pressing plants, in 1989, will produce more than 500 million compact-discs according to these specifications, and manufacturers of compact-discs players are legion, at least for the CD-Audio players and the CD-ROM drives. In 1990, more than **BILLION** compact-discs should be manufactured. This is De Facto promising a **very long lifetime to the compact-disc standards themselves, and the availability of players during the next decades.**

Both Compact-disc standards and Century products lifetime make the Century products the safest archiving media available worldwide today.

4.3) The century products manufacturing costs

The portion of the compact-disc manufacturing represents typically 10% or less of the overall production budget of one compact-disc title. A Century-Master™ archive option will thus represent between 0,5 and 2% of such a budget. How much will it cost to editors to re-produce or lose their data in the next decades -

Additionally, the century products will play in \$200 CD-Audio players, \$600 CD-ROM drive, \$800 CD-Video player, meaning enormous savings on archiving systems configurations.

Century-Discs serialized limited edition of one CD title, by combining rarity and lifetime, represent a great investment to potential buyers: they will gain economic and historic value with time. Great music pieces, movies or videoclips, images, literature, software and computer data are finally finding the right conservation medium. Because it is a part of our human heritage, their preservation is certainly worth our manufacturing costs.

Last, but not least, the availability of this fantastic product is due to our unique research program. The unit cost of the century products will decrease as the cost of materials drop and investment is recovered.

EVOLUTION OF CENTURY PRODUCTS MANUFACTURING COSTS (U.S. \$)

	1989	1992	1995
CENTURY-MASTER™	1100	800	500
CENTURY-DISC™	240	180	100

Unit price in addition to traditional CD mastering service

5) Century products markets and applications

5.1) Profile of the Century products

We can summarize the CENTURY products in a few properties:

- will last for a century at least in standard conditions, and gain historic and economic value with age,
- is made with only noble and stable inorganic materials including tempered glass and gold,

- will resist to scratches and abrasion, shocks, corrosion, radiations, high temperatures, humidity, and can even be remetalized after many strong chemical attacks without any apparent lost of data...,
- will play in any CD-AUDIO, CD-ROM, CD-I or CD-Video low-cost players,
- store any kind of prerecorded data:
 - up to 74 mn Super-Hi-Fi stereo digital sound (CD-AUDIO)
 - up to 660 Mbytes of data or about 200 000 pages of text (CD-ROM)
 - up to 19 hrs of digital sound or 10 000 high resolution color images (CD-I, CD-XA)
 - Up to 1 hr or 54 000 images of High Quality video with CD-Audio sound (CD-VIDEO),
- combines compactness, lightness and high storage density with reliability,
- is beautiful, rare (CENTURY-DISC™) or even unique (CENTURY-MASTER™)

5.2) Century products applications

Century Master™ and Century Disc™ markets include applications such as:

5.2.1) Systematic back-up of any Compact-disc title with either a **single archive** (Century-Master™) or **multi-archiving** (Century-Disc™): a long term archiving of phonograms, videograms or computer data/software can then be provided to **government archiving institutions, editors and customers.**

An example, in CD-ROM format, is to propose a Century-Master version to the National Library, Century-Disc to main libraries and polycarbonate versions to end-users. Churches are equally looking for very long-term archiving mediums.

5.2.2) Limited numbered editions of musical and/or video compact-discs

In CD-Audio and CD-Video formats, a limited serialized Century-Disc edition will delight producers, editors or artists, as Century-Discs can also be used as truly payable "Gold" or "Platinum" discs. On the end-user side, amateurs, collectors or fans of artists will get their "lifetime CDs".

Collectors today buy original 30 or 40 years-old Elvis Presley vinyl disc for \$1,000... and collectors of Art or literacy masterpieces spend a lot more for >100 years original or limited editions!

5.2.3) On-board civil data systems

For mapping, navigational assistance, technical documentation (maintenance, diagnosis, schematics...) on-board systems, demanding specifications optical media and drives are necessary. DIGIPRESS is already in touch with several companies developing ruggedized CD-ROM players for such applications.

Today, several car prototypes including on-board national or European maps have already been shown to restricted audiences. In the civil domain, all the major companies in the field aerospace, aeronautic, train transportation, cargos and ships are evaluating the use of CD-ROM as a new way to store maps, routes, technical assistance and other on-board data.

Satellites also need massive amount of on-board prerecorded computer data. For all these applications, the century products are the more reliable optical media ever made.

5.2.4) Data storage applications in severe industrial environments

As a light, portable or fixed mass memory, Century-Discs can be used in severe environments. Their, extreme resistance to abrasion, scratches, saline and/or humid atmosphere, electromagnetic fields and temperature meet the requirements of design engineers and integrators.

For applications such as robotized manipulators in nuclear plants, data systems in petrol platforms, control systems for factory floor production lines, control assistance for industrial robots applications, Century-Disc offers a new level of reliability in mass data storage never reached before at a relative low cost.

5.2.5) Military applications

Whenever information stored has a strategic value, Century-Disc should be used. They will soon prove their compatibility with the most severe environmental military specifications, such as class IV military airborne specs. DIGIPRESS will ensure total security in information provided with master tapes.

All military applications requiring the use of massive information in a compact space, including the portable ruggedized data systems should consider the Century-Disc technology.

6) Integration of the Century offer with DIGIPRESS services**6.1) Company profile**

DIGIPRESS was founded at the end of 1985 by a group of optical disc engineers and financial and industrial partners. The arrangement with shareholders guarantees the total independence of the company.

At the end of 1988 DIGIPRESS employed 31 persons and had invested more than 6M\$ in its factory tool. Turnover for 1988 approached 3M\$.

6.2) Products and services**PRODUCTION OF MASTERS AND STAMPERS: more than 25 plants trust our quality**

DIGIPRESS offers the international market **MASTERING** and **ELECTROFORMING OPTICAL DISCS** and specially **COMPACT-DISCS** (CD Audio, CD Video, CD-ROM, CD Interactive). DIGIPRESS has been the first European independent service company offering this service. Our reliability, added to the exceptional level of quality of our masters and stampers are internationally recognized: more than 25 pressing plants use them today, and our factory's annual output is greater than 6 000 masterings.

DIGIPRESS CENTURY PRODUCTION: a revolution in optical discs manufacturing

DIGIPRESS expertise in optical disc recording has been applied to a research - development program with European partners. This program has developed a new tempered glass etching technology applicable to any optical media format which places the company in a leading position worldwide. This technology is particularly suited to limited series production of high quality optical media

DIGIPRESS SERVICES: the most complete optical media manufacturing service available worldwide

Mainly for professional applications DIGIPRESS proposes as well a complete range of services for manufacturing polycarbonate CD's in various formats and with special packaging. CD pack™ for example has been developed by DIGIPRESS specially for CD-ROM markets. DIGIPRESS specializes in limited series products manufacturing. Its unique position in the COMPACT-DISC industry make it possible to offer every option on its services:

Formats: CD-AUDIO, CD-ROM, CD-XA. CD-I, CD-V or videodisc, WORM or RWM (erasable) optical disc formats.

Diameter: 8 cm, 3,5 inches, 12 cm, 5,25 inches, 20 cm, 8 inches...

Substrate:

- traditional polycarbonate for series,
- photoresist coated glass for test discs,
- etched glass (discs or substrates compatible with all mentioned formats):

CENTURY-MASTER™ archiving disc, made in units, and **CENTURY-DISC™**, its replicated version made by small series.

Disc graphics: silk-screening (1 to 4 colours), pad-printing, other special processes...

Disc packaging: simple or multiple jewel boxes, hardpaper sleeves, jewel cases...

Other elements to be integrated to the final product: books, manuals, posters, floppy discs...

Comment

This article, which contains an undoubtedly strong commercial message has been published because it contains extremely valuable technical information of interest to librarians and other users.

Editor
