Testing recordable media at high speed – only logical

High speed testing of recordable media makes sense: 'faster is better' is logical against increased throughput of testing – provided as the quality of the result is maintained compared with the traditional 1X (standard) approach. However, there are some specific benefits of high-speed testing that go above and beyond this intuitive justification.

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There are three main benefits of high-speed testing for recordable media.

First, for the disc manufacturer, faster testing gives more immediate feedback for adjusting the manufacturing process when disc quality moves outside of the ideal limits.

Second, drives replay at ever-higher speeds to allow faster copying, reading onto hard drives, etc. Here if the drive cannot replay at higher speed, discs can 'freeze', or the time taken to use the data on a disc becomes unacceptably slow. Testing at higher speed gives far more certainty of final playability at higher speed.

Third, and perhaps of even more significance for disc manufacturers than *reading* data at high speed, is the market demand for blank media to be *written* to at increasingly higher write (burn) speeds. Here, higher speed testing can be used to detect effects, not present at 1X, that can directly be used to optimize disc properties to allow for burning them at higher write speeds.

High speed writing

Today, the consumer wants higher write speeds – faster is better. This market demand is met, by the write drive manufacturers, with the promotion of ever faster write capability. That speed is now 52X for CD-R; for DVD+R the holy grail is 16X. To match expectations the media itself must be able to achieve these speeds. This 'faster is better' issue is used effectively by media producers to differentiate themselves from competitors – a media supplier who does not market recordable discs with higher speed capability is an 'also ran'. In addition, a premium for higher speeds can be charged to – is, in fact expected by – the consumer.

The issue then becomes one of how can one ensure that, for instance, a CD-R made for 52X writing actually meets this speed?

This can be confirmed by writing on a range of writers, from different manufacturers, to ensure that they are all writing at the stated speed. However, this is not practical in the manufacturing process control – writers either work at the required speed or, if they fail, drop back to write at a lower speed. A pass/fail only result provides no feedback on what is causing the inability to write at the higher speed.

People often overlook the crucial fact that blank media must be 'read' as it is being written. The process of burning data onto a blank disc demands that the data is written to specific physical locations. If not, then it will be impossible for a player to read the data back later. A drive determines where data is written to by reading back and correctly interpreting the pre-groove structures embedded into the disc at the time of manufacture.

The sequence includes tracking and focusing on the spiral pre-groove (the speed of disc rotation must then be locked to this wobble signal); and the ATIP, ADIP, or LPP addressing information must be read and decoded to determine the final physical location. If this pre-groove is not properly identified, then the writer will not be able to properly burn the information onto the groove and the disc will not play back.

The ability to read this wobble data becomes increasingly challenging at higher speeds. Reading back data at higher speeds is more demanding, given the higher frequencies and physical effects arising from spinning the disc faster. It is, therefore, more logical to evaluate these speed-related effects at higher speed –trying to determine these by testing at 1X is likely to fail as, by definition, these high speed effects are only seen at the higher test speeds. It is virtually impossible to predict high speed playability behaviour by testing at 1X.

Problems that impact on the ability to write to recordable media come from a combination of effects including the mechanical properties of the disc, the dye (recording layer) properties, the mastering of the stamper that made the disc, and the moulding of the final groove structure.

Some mechanical disc properties that can cause problems include dishing (flatness or otherwise of the disc); eccentricity; and unbalance. If erroneous, these properties will hinder the focus and tracking servos of the writer/player. These are critically speed-dependent for the read-prior-to-write function.

Effects caused by the mastering of the stamper are often detected by checking the ATIP/ADIP/LPP error rate. For moulding-related problems, parameters that can be checked are focus error, radial noise, and push-pull. Again, error rates can be critically related to the speed of the drive.

Whatever the underlying reason, if the drives laser system has trouble staying within the groove during the read-prior-to-write function, then it is clear that writing to the disc will almost certainly be problematic.

It is worth noting that when it comes to problems with the dye properties, and the underlying process of how the dye interacts with the disc's polycarbonate in the write process, these can only be practically detected by the test equipment by testing the media after writing. Reading the pre-groove of a blank unwritten disc is one thing – and a specific requirement of a disc and writer combination. The final test however, ideally at high speed, is one that mimics that of conventional pre-recorded discs: 'Can the data written to the disc be read back?'. Exception to this might be when the dye is completely outside specification, for instance, on density, where the disc will fail even on tests prior to being written.

Full analysis of recordable media, therefore, requires testing of both blank and written discs. If a combination of the influences on quality (moulding, dye, and writer) are taken into account, then a sample of each combination will mean that many discs per day or per shift need to be checked. Clearly, high-speed testing provides a huge advantage over simply testing at 1X, in terms not only of disc quality, but also of quantity.

Testing to the standard

This high-speed approach can, however, lead to concerns given that the specifications call for testing at 1X, or 'standard', speed. One question often asked is, 'How can one test at high speed when the specification is for 1X?'

All discs made with to a 1X specification must comply with this specification. While this is on a sample-only basis (testing every disc is tested would be cost prohibitive), these samples do still need to be tested for compliance. So, can high speed testing be used to verify the discs against a specification which requires 1X playback? The answer here is a qualified 'yes'.

If a disc passes when being tested at a higher speed (say 8X), it will pass that specification at 1X. Of course, if a portion of a disc fails at a higher speed, it should be re-tested at 1X to verify specification compliance. As discussed earlier, failures at higher speed that are not present at

1X often point to underlying issues that can directly impact on writing (and reading) at higher speeds.

In conclusion, the advantages of high-speed testing of recordable media are numerous, both those that are specifically quantifiable and those that are rather more intangible. Tests will have greater reliability, due to the wider scope of results that can be obtained in a shorter space of time. The reputation of a disc producer will be enhanced through the consistent shipment of higher quality products. And, of course, money is saved through less downtime, fewer rejects, and overall optimization of the production process with higher yields.