

Phase-change rewritable dual-layer media

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Abstract

In this talk an overview on dual-layer phase-change media is given. The media is developed for recording with a blue laser and a high numerical aperture objective. Both recording stacks of this medium are based on eutectic Sb-Te alloys (FGM-materials). Different media designs are compared and suitable write strategies are discussed. Special attention is given to the transmission difference between recorded and unrecorded state of the semitransparent stack. The influence of this transmission difference on recording performance is analysed.



Phase-change dual-layer media: an overview

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*E*PCOS2003
Lugano, Switzerland
10-11 March 2003*

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Phase-change rewritable dual-layer media

Contents

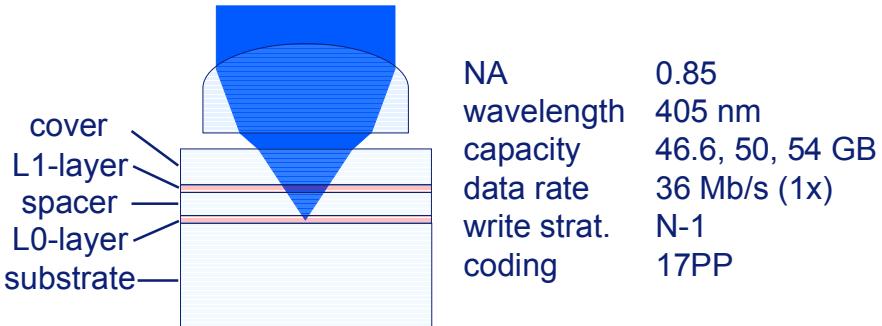
Introduction: dual-layer Blu-ray Disc

Issues:

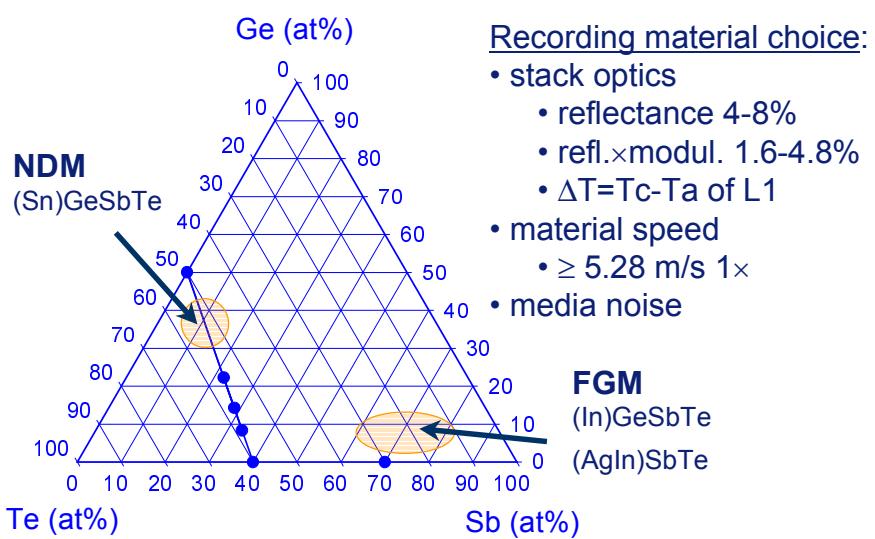
- phase-change material choice
- stack designs & write strategies
- limitations for transmittance difference

Conclusions

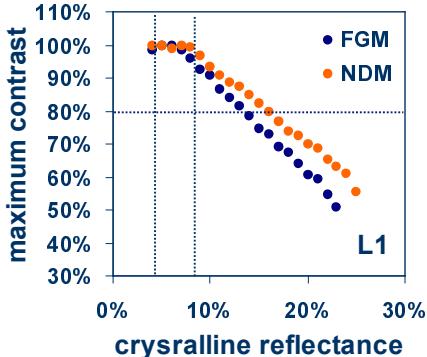
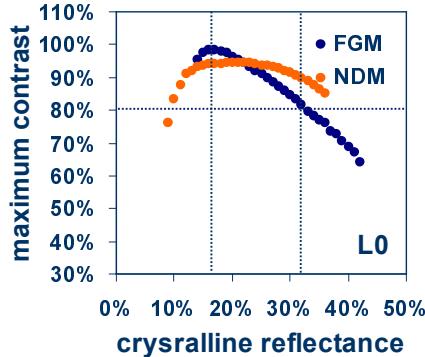
Rewritable dual-layer Blu-ray Disc



Phase-change material choice



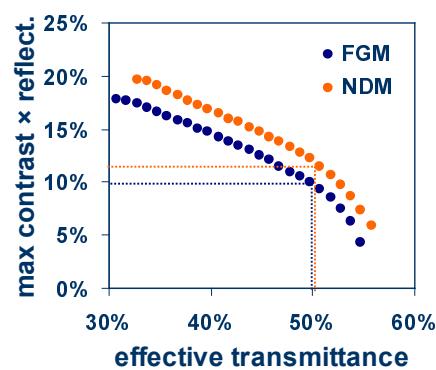
Recording stack optics



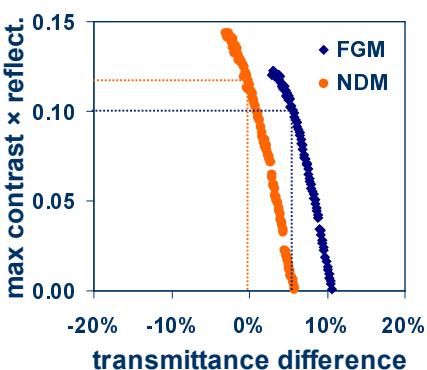
L0 reflect. = 16-32% ($xT^2(L0)=4-8\%$)
L0 contrast > 80%

L1 reflect. = 4-8%
L1 contrast > 80%

Recording stack optics

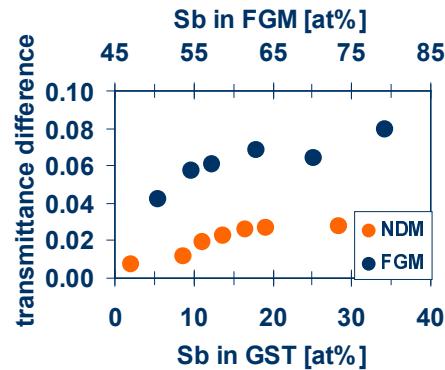


$C \times R$ (FGM) $\approx 10\%$
 $C \times R$ (NDM) $\approx 12\%$



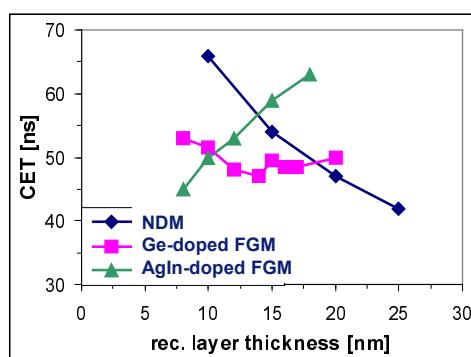
ΔT (FGM) $\approx 6\%$
 ΔT (NDM) $\approx 0\%$

Recording stack optics



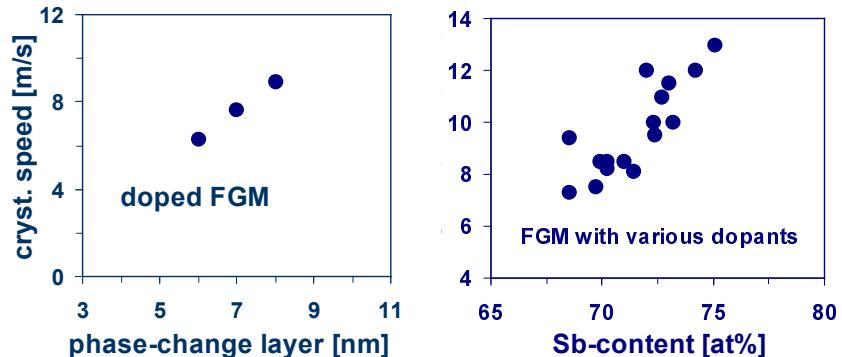
Optically NDM seem to be advantageous to FGM

Phase-change material speed



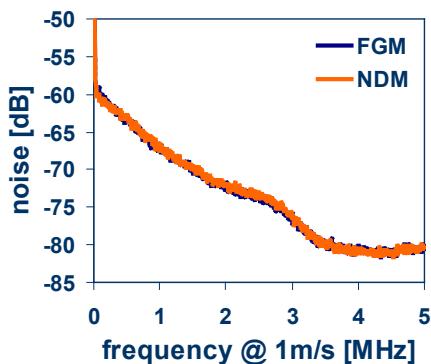
In the case of thin layers FGM materials appear to be more attractive

Phase-change material speed



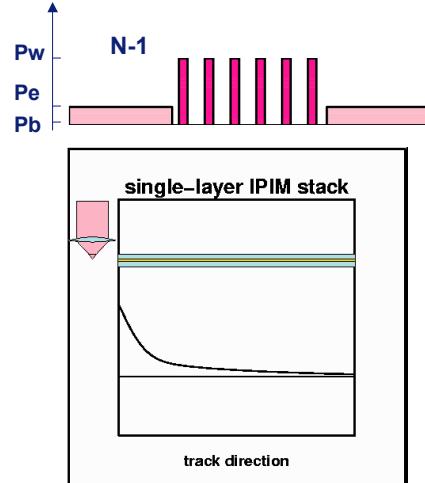
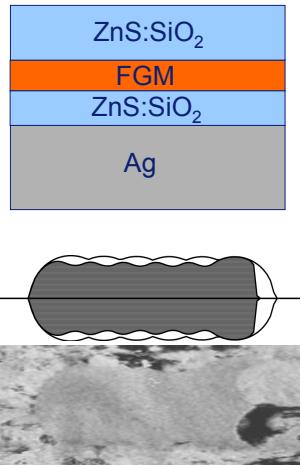
Use of FGM materials in both recording stacks is desired for high-speed media development

Phase-change material noise



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L0 design and write strategy

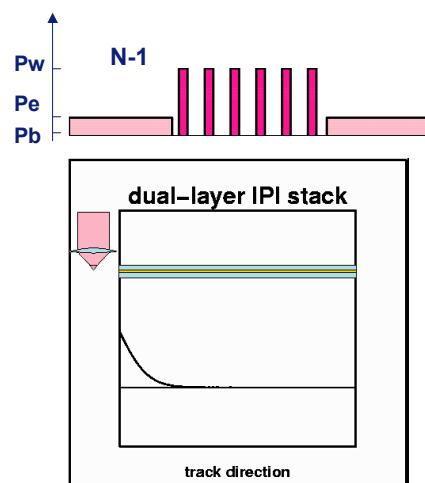
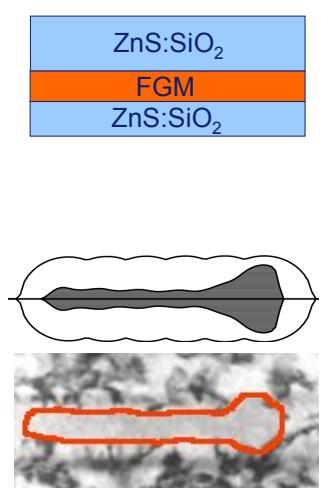


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L1 designs and write strategies

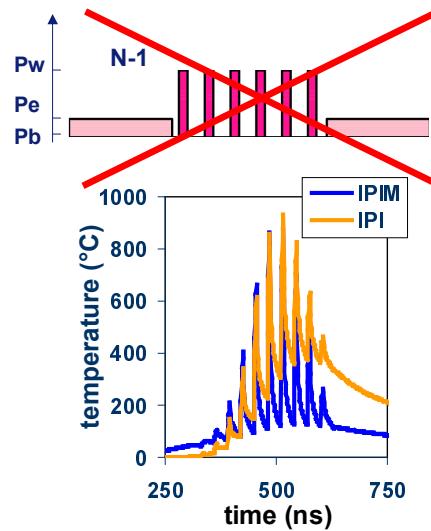
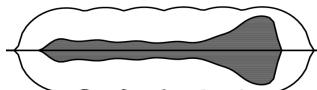
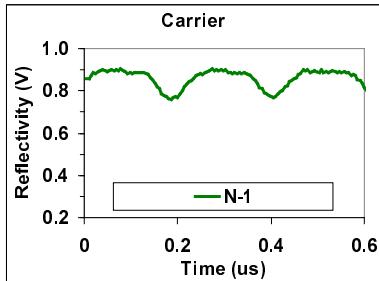


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L1 designs and write strategies

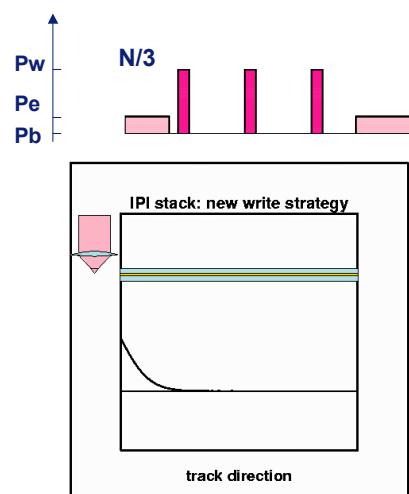
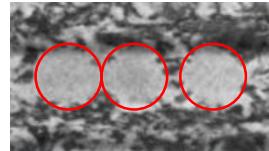
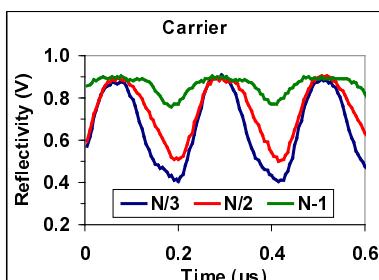


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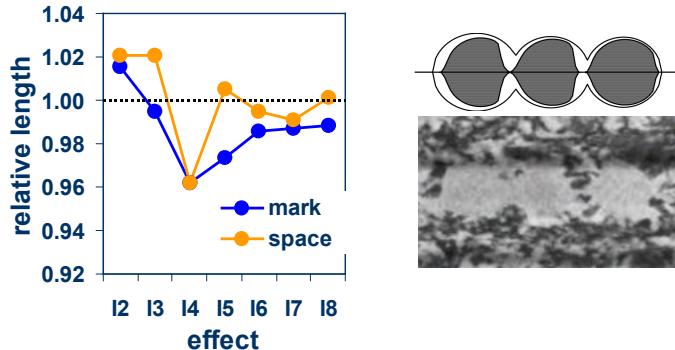
L1 designs and write strategies



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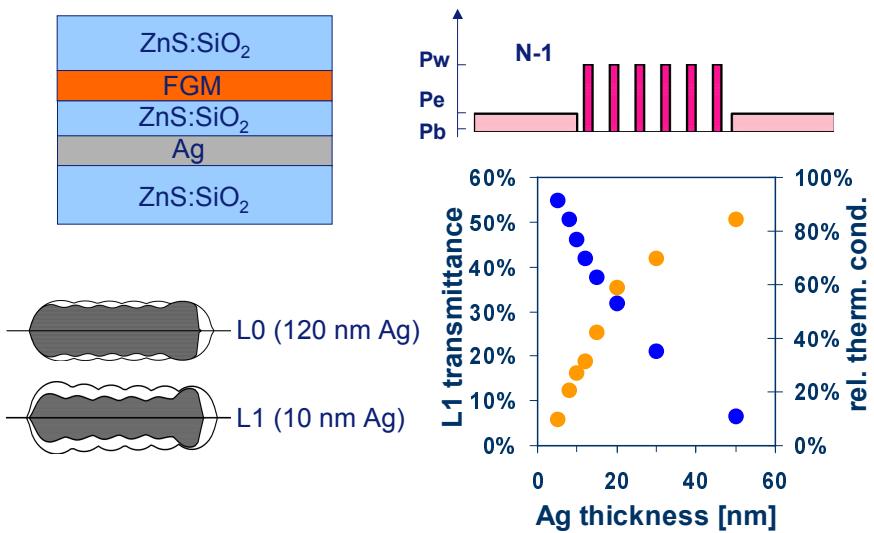
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L1 designs and write strategies

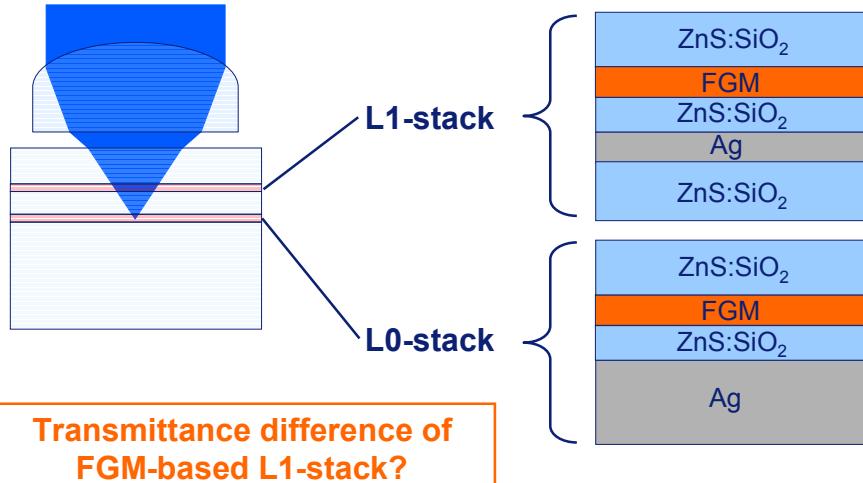


- complexity of write strategy
- discrete shape of marks

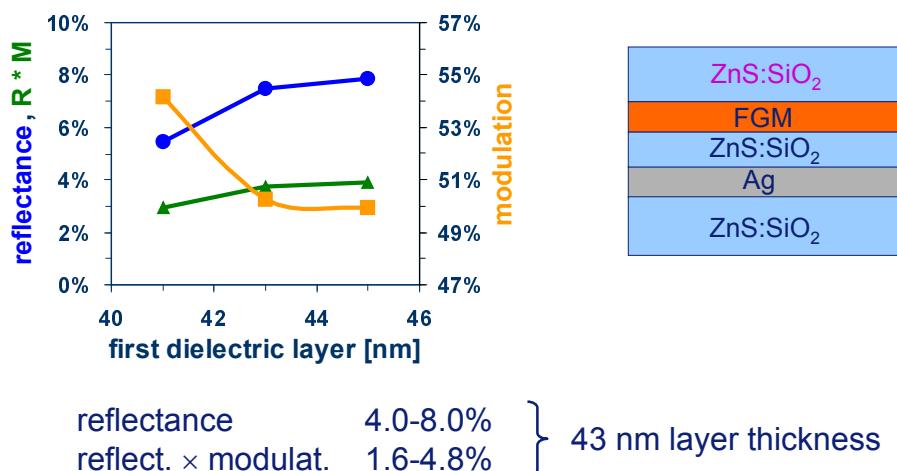
L1 designs and write strategies



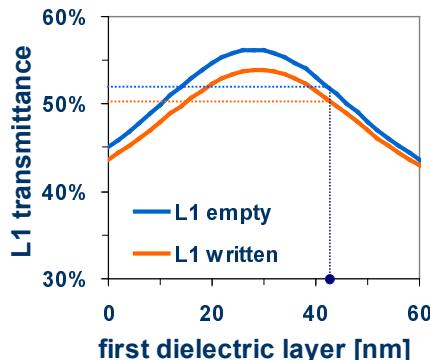
Recording stacks design



Semi-transparent L1 stack



L1 transmittance difference



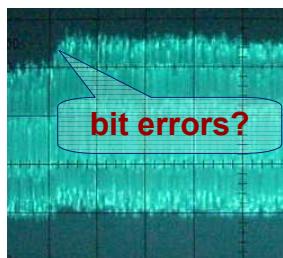
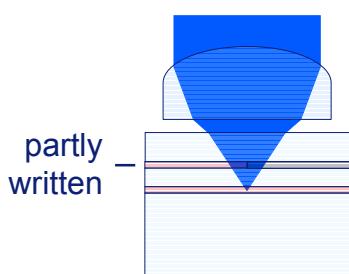
crystalline transmittance 52%
amorphous transmittance 44%

effective transmittance of
written state (groove-only):
 $T_{eff} = (3/4)T_c + (1/4)*T_a$

empty state transmittance 52%
written state transmittance 50%

**Effective transmittance of L1 depends
on its recorded state**

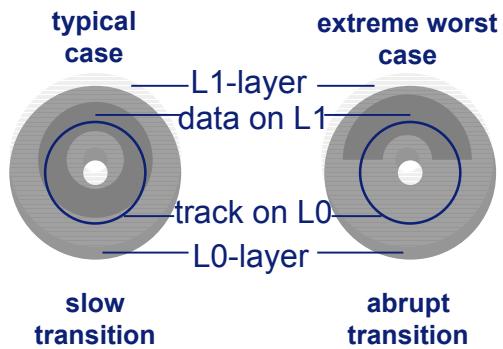
L1 transmittance difference



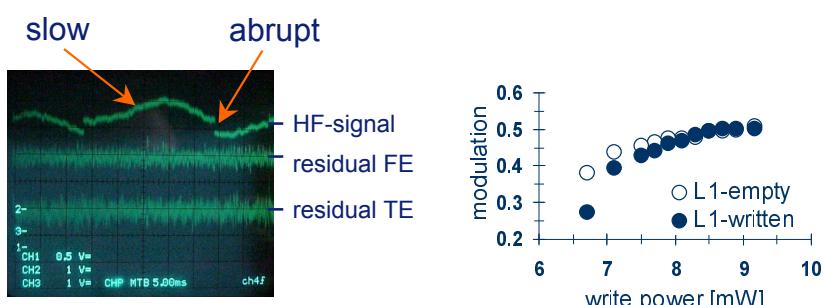
L0 data written and
read-out through partly
recorded L1

$\Delta T/T$ of L1 about 4-5%
 $\Delta R/R$ of L0 about 9-10%

L1 transmittance difference

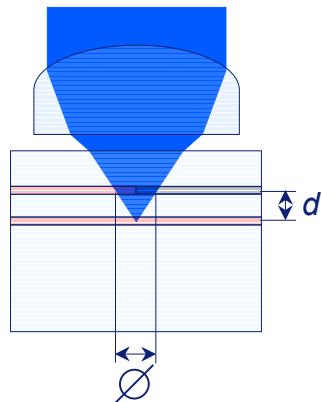


L1 transmittance difference



No influence of transmittance difference of FGM-based media on servo signals and power margins

L1 transmittance difference



$$\varnothing = 2 \times \frac{d \times NA}{\sqrt{n^2 - NA^2}}$$

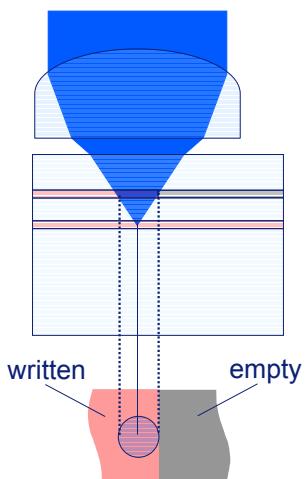
$$NA = 0.85$$

$$n = 1.6$$

$$d = 20-30 \text{ um}$$

$$\varnothing = 25.1-37.6 \text{ um}$$

L1 transmittance difference



$$\varnothing = 2 \times \frac{d \times NA}{\sqrt{n^2 - NA^2}}$$

$$NA = 0.85$$

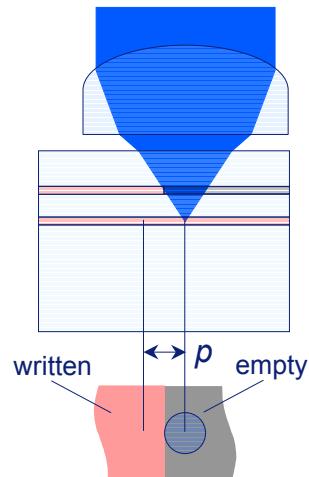
$$n = 1.6$$

$$d = 20-30 \text{ um}$$

$$\varnothing = 25.1-37.6 \text{ um}$$

: worst-case scenario

L1 transmittance difference



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$$\varnothing = 2 \times \frac{d \times NA}{\sqrt{n^2 - NA^2}}$$

$$NA = 0.85$$

$$n = 1.6$$

$$d = 20-30 \text{ um}$$

$$\varnothing = 25.1-37.6 \text{ um}$$

23.3 GB: $p_{min} = 314$ channel bits

25.0 GB: $p_{min} = 337$ channel bits

: worst-case scenario

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L1 transmittance difference

user SER $\leq 2 \times 10^{-3}$

acceptable SER
level due to ΔT $\leq 1 \times 10^{-4}$

worst-case scenario:

- one transition per ECC-block
- transition length 314 chan. bits (23.3GB)
 337 chan. bits (25.0GB)

1 ECC-block ≤ 962000 chan. bits ≤ 65600 user symbols

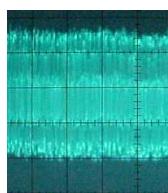
SER $\leq 1 \times 10^{-4}$ ≤ 6.56 symb.err./ECC

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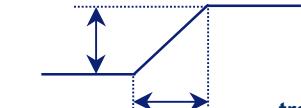
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L1 transmittance difference

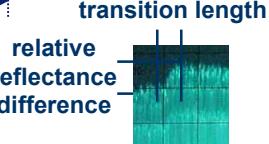
normal HF signal



Jump generated by a step-function generator

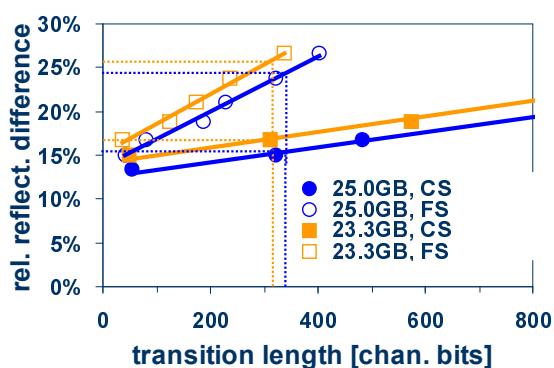


vary transition length and amplitude



take combinations when $SER = 1 \times 10^{-4}$

L1 transmittance difference



CS=conv. slicer

FS=fast slicer

CS: about 16%

FS: about 25%

At Blu-ray Disc conditions: Transmittance difference of L1 causing relative reflectance jump of L0 of up to 25% can be allowed

Conclusions

Blu-ray Disc dual-layer media with both stacks based on FGM-type material

Two types of L1 design:
IPI + N/3 (3T) write strategy
IMIPI + N-1 (1T) write strategy (preferred)

No influence of transmittance difference of semitransparent L1-layer on the performance of L0-layer

With fast-slicer concept limitations on transmittance difference are lifted

