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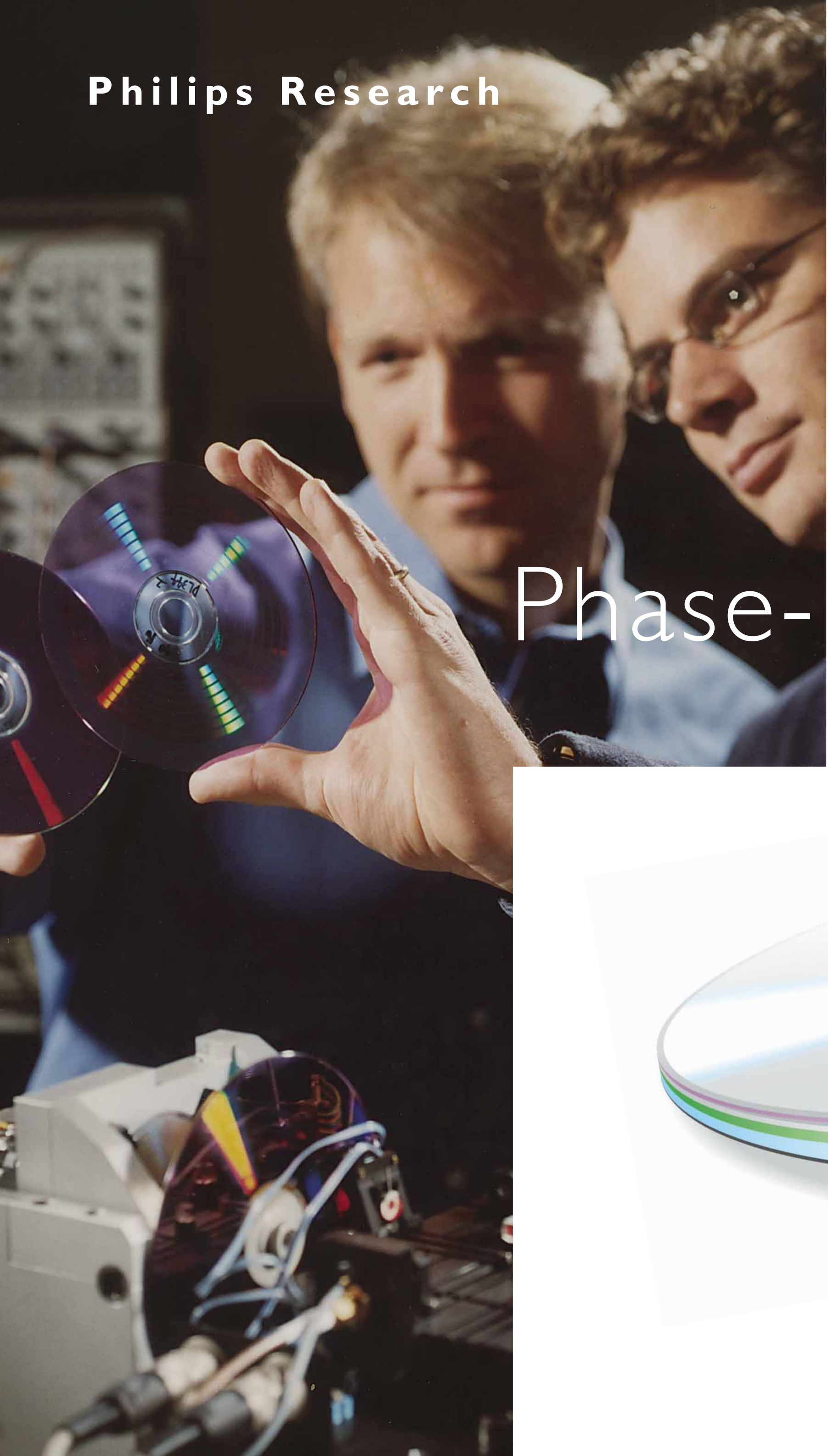
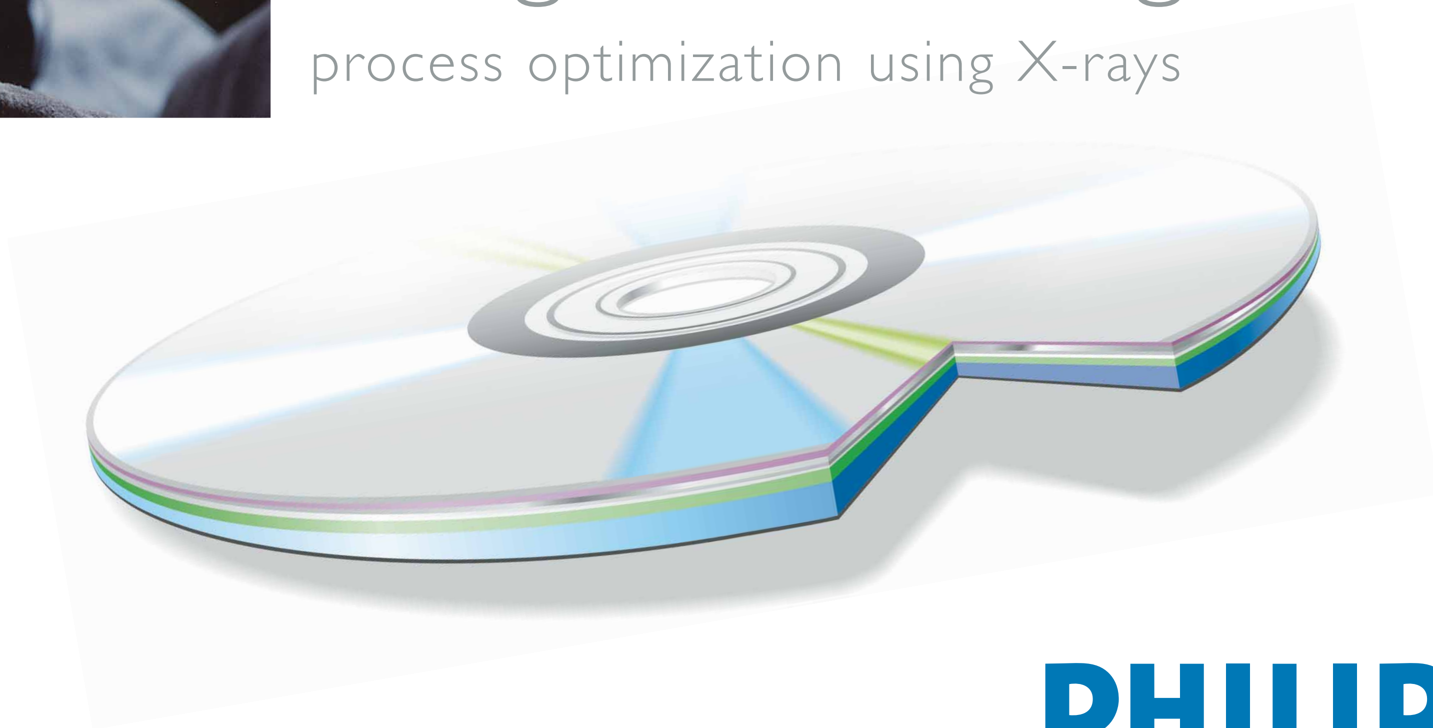


Phase-change optical recording is a challenging technology for data storage that is used in CD and DVD rewritables. It is based on localized laser induced heating of a thin layer, which causes a phase transition from crystalline to amorphous. This transformation results in optical reflectance differences. The composition and thickness of the various layers in these rewritable discs are very important parameters, which have to be optimized.

Phase-change Recording

process optimization using X-rays



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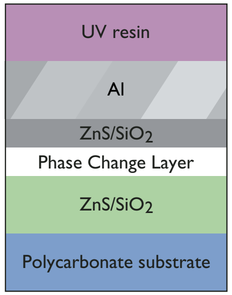
target			layer		
Ge	Sb	Te	Ge	Sb	Te
22.8	22.2	55.0	22.0	22.9	55.1
23.1	21.2	55.6	22.9	21.8	55.3

Table 1: Target vs. layer composition (atom %)

X-ray fluorescence spectrometry (XRF) and X-Ray Reflectometry (XRR) are used to analyze the composition of the recording layers of the optical disc and the conformance of the layer deposition processes. The high reproducibility of XRF and its automation make this technique very suitable for process control and for assessing trends in series of samples.

The combination of sophisticated analytical techniques allows complete characterization in terms of composition, thickness, density and roughness of single- and multilayer systems.



	In	Sb	Te	Ag
Target	11.2	52.6	32.7	3.5
S1	10.8	54.0	31.5	3.66
S2	10.9	53.9	31.6	3.66
S3	10.8	53.9	31.6	3.67
S4	10.8	54.0	31.5	3.65

Table 2: Reproducibility (atom %)

Structure of a rewritable disc

The phase-change optical layer consists of a multilayer stack on a polycarbonate substrate (see figure). A phase-change layer, containing a GeSbTe or AgInSbTe alloy, is sandwiched between dielectric layers of ZnS/SiO_2 with a reflective layer of an Al alloy on top. A UV-resin layer covers the stack for protection. The thickness and composition of each layer is important, because mechanical, optical and thermal characteristics are influenced by the entire layer structure.

Control and optimization of the active layer deposition process

Phase-change layers are deposited by sputtering from alloy targets. However, the composition of the target and the deposited materials is not necessarily the same. As the final composition of the phase-change layer is of prime importance, the relationship between target composition, layer composition and deposition conditions has to be established. Moreover a robust deposition process should result in reproducible and constant layer compositions.

Table 1 gives some analytical XRF results for two targets and corresponding layers showing a good relationship between target and layer composition. A good reproducibility of the sputtering process is shown in Table 2, which gives XRF results for different sputtered samples with the same target.

	thickness	element	at%
UV resin	5 µm		
Al	235 nm	Al	99.14
		Ti	0.86
ZSn/SiO_2	51 nm		
AgInSbTe	16.5 nm	Ag	5.34
		In	5.04
		Sb	61.3
		Te	28.3
ZnS/SiO_2	120 nm		
Polycarbonate	1.1 mm		

Table 3: Stack analysis

Product analysis

XRF can also be applied to obtain compositional information on finished products or components. Fast reliable compositional information can be obtained by thin film analysis. An example is the analysis of a complete disc for phase-change optical recording. The measured thickness and elemental composition of the various layers is shown in Table 3.

The analysis was performed using thin-film standards, where thickness was calibrated on RBS (Rutherford Back Scattering) data.

X-ray reflectometry (XRR)

Accurate layer thickness and roughness determinations can be done with XRR. As X-rays are scattered by different interfaces, structure information can be obtained from the interference spectra. The figure below shows the XRR interference spectra of a single GeSbTe layer and the same layer in a stack configuration with Al and ZnS. Note that the thickness of the various layers can be determined non-destructively. This particular GeSbTe layer has a thickness of 25 nm.

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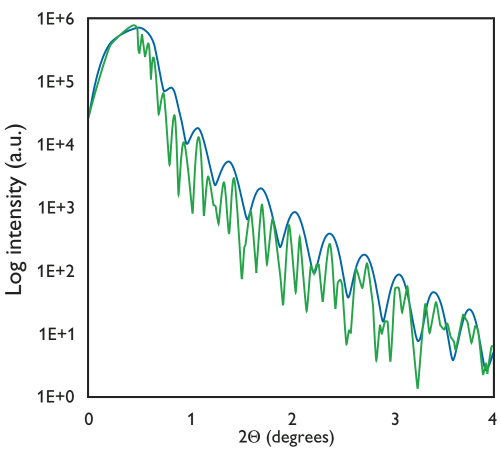
XRR interference spectra



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