Specification

Physical and chemical properties

PCP
RD 50™

RD 50™

Radiation shielding glass RD 50™ protects against X-rays and gamma rays in the medical and technical field. In research works it also provides necessary safety screening.

RD 50™ is an extra dense flint glass. Its protective effect is based on its high content of heavy metallic oxides of nearly 70 per cent by weight. The lead oxide content alone is more than 65 per cent by weight. Therefore, a density of above 5.05 g/cm³ is reached, so that relatively small thicknesses fulfil all legal safety regulations. Radiation shielding glass RD 50™ meets the requirements of DIN EN 61331-2. The protective capacity of a radiation shielding glass for X-rays is indicated by the attenuation equivalent, either in relation of lead thickness to glass thickness in per cent or in mm Pb.

The subsequent properties are based primarily upon the measuring results of the very latest standards and measuring methods, which are defined in corresponding "Measuring and Test Procedures".
We retain the right to change the data in keeping with the latest technical standards.
Non-toleranced numerical values are reference values of an average production quality.

Values marked with ◊ do not apply to the type of glass or no values are available.

Requirements deviating from these specifications must be defined in writing in a **customer agreement**.

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1.	**Optical properties**		
1.1	**Refractive index**	n_D	1.79
1.2	**Transmittance data**		
1.2.1	**Spectral transmittance τ (λ)**		
1.2.1.1	**τ (λ) - curve**		
	Plot of spectral transmittance τ (λ) for d = 5.0 mm, d = 10.0 mm, d = 20.0 mm (λ = 340 nm to 800 nm)		see annex
1.2.1.2	**τ (λ) - individual values in % (d = 10 mm)**		
	τ at λ = 550 nm	τ_{550}	85
1.2.1.3	**Edge wavelength (d = 5.0 mm)**		
	Edge wavelength $\lambda_{c\ (\tau = 0.46)}$ in nm		397
1.2.2	**Luminous transmittance τ_v as a function of thickness**		

Thickness in mm	τ_{vD65} in %	τ_{vA} in %
5.0	85	85
10.0	84	84.5
20.0	82.5	83

2.	**Thermal properties**		
2.1	**Viscosities and corresponding temperatures**		

Designation	Viscosity lg η in dPas	Temperature ϑ in °C
Strain point	14.5	444
Annealing point	13.0	467
Softening point	7.6	603
Forming temperature	6.0	673
Forming temperature	5.0	729
Forming temperature	4.0	800

2.2	**Transformation temperature *Tg* in °C**	467
2.3	**Coefficient of thermal expansion α**	
2.3.1	**Coefficient of mean linear thermal expansion α(20 °C;300 °C) in 10^{-6} K^{-1}** (Static measurement)	7.4
2.4		disregard
2.5	**Mean specific heat capacity c_p(20 °C to 100 °C) in J/(g · K)**	0.39
2.6	**Thermal conductivity λ in W/ (m·K) for 50 °C**	0.62

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3.	**Mechanical properties**	
3.1	**Density ρ in g/cm³** (Condition as supplied)	≥ 5.05
3.2	**Stress optical coefficient *C* in 1.02 · 10^{-12} m²/N**	0.78
3.3	**Breaking strength**	disregard
3.4	**Young´s modulus *E* in kN/mm²**	56.6
3.5	**Poisson´s ratio μ**	0.245
3.6	**Torsion modulus *G* in kN/mm²**	22.7
3.7	**Knoop hardness *HK* 0.1/20**	360
4.	**Chemical properties**	
4.1	**Hydrolytic resistance acc. to DIN ISO 719**	
	Hydrolytic class	HGB 1
	Equivalent of alkali (Na_2O) per gram of glass grains in µg/g	24
4.2	**Acid resistance acc. to DIN 12 116**	
	Acid class	◊
	Half surface weight loss after 6 hours in mg/dm²	◊
4.3	**Alkali resistance acc. to DIN ISO 695**	
	Class	A 3
	Surface weight loss after 3 hours in mg/dm²	510
5.	**Electrical properties**	disregard

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6.	**Other properties**		
6.1	**Attenuation equivalent for lead in % of glass thickness for different types of radiation**		
6.1.1	**X - radiation quality**		
6.1.1.1	**Nominal thickness 0.65 cm (5 mm to 6.5 mm),**		
	Nominal thickness 0.75 cm (6 mm to 7.5 mm)		
	Tube voltage	80 kV/0.16 mm Cu total filtering	30.1
	Tube voltage	90 kV*/0.20 mm Cu total filtering	30.7
	Tube voltage	100 kV/0.25 mm Cu total filtering	30.5
	Tube voltage	110 kV*/0.40 mm Cu total filtering	30.5
	Tube voltage	150 kV/0.70 mm Cu total filtering	30.1
	Tube voltage	200 kV/1.20 mm Cu total filtering	28.6
6.1.1.2	**Nominal thickness 0.85 cm (7 mm to 8.5 mm)**		
	Tube voltage	80 kV/0.16 mm Cu total filtering	29.2
	Tube voltage	90 kV*/0.20 mm Cu total filtering	29.3
	Tube voltage	100 kV/0.25 mm Cu total filtering	30.2
	Tube voltage	110 kV*/0.40 mm Cu total filtering	30.9
	Tube voltage	150 kV/0.70 mm Cu total filtering	30.2
	Tube voltage	200 kV/1.20 mm Cu total filtering	28.8
6.1.1.3	**Nominal thickness ≥ 1.0 cm (> 8.5 mm)**		
	Tube voltage	90 kV*/0.20 mm Cu total filtering	29.9
	Tube voltage	100 kV/0.25 mm Cu total filtering	30.0
	Tube voltage	110 kV*/0.40 mm Cu total filtering	30.0
	Tube voltage	150 kV/0.70 mm Cu total filtering	30.1
	Tube voltage	200 kV/1.20 mm Cu total filtering	28.9
	*Tube voltage not enclosed in DIN EN 61331-1 For tube voltages > 200 kV the attenuation equivalent for 200 kV should be taken as basis		
	Measuring and Test Procedures **(TÜV NORD RÖNTGENTECHNIK TÜV Hannover / Sachsen-Anhalt e.V.)**		
	General The tests were performed at the technical center of TÜV Hannover/Sachsen Anhalt e. V., as well as the radiology clinic of the Henriettenstiftung Hannover, using the STABILIPAN therapeutic unit from Siemens.		

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Test Setup

The test setup took place in accordance with DIN 6845 T1 taking into consideration the geometries for measurements within a narrow beam of rays. Specimens with the dimensions 120 mm x 120 mm were aligned inside an erected channel formed using lead bricks so that they could be irradiated on a surface of 50 cm² in the middle of the sample. The aperture with the apparatus for insertion of the Cu filter was positioned near the focal point and at the end of the measuring channel in the middle of the central beam to achieve the radiation quality required by the DIN standard. To minimize radiation scattering that can be expected as a result of the high energy, the area between the ray exit window and the aperture was shielded with an additional 1.0 mm of lead.

Used measuring devices

· Dosimeter Diados	QS-No.: 400152
· Lead foil	QS-No.: 400151
· Monitor Dosimeter	QS-No.: 400037
· Radiator MCN 165	QS-No.: 420505
· Cu Filter	QS-No.: 400216

Attenuation equivalent in mm Pb

To determine the attenuation equivalents, the specimen was comparatively measured using lead foil with various thicknesses. The attenuation equivalent was determined through linear interpolation from the measured dose rates behind two lead foils with varying thicknesses and the specimen.

6.1.2 Gamma radiation

6.1.2.1 Tests PTB

^{60}Co	38.3
^{137}Cs	35.8
^{131}I	33.6
^{192}Ir	28.2

Measuring and Test Procedures (PTB Braunschweig)

For X-radiation (constant voltage) the lead equivalent is defined by the radiation quality specified in the table and for gamma radiation with the radiators indicated in the above table.

The exposed area has a diameter of 50 mm. The attenuation of radiation by the test specimen is compared with lead of such a thickness that same attenuation of the dose rate is achieved in both cases.

As detector, a scintillation dosimeter (scintillator 44 mm diameter, 15 mm height) is used. The measuring inaccuracy declared by the PTB has been substracted.

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6.2 **Linear attenuation coefficients (μ) and tenth-value layers (TVL)**

Nuclide	Energy in MeV	μ in cm^{-1}	1 TVL in cm		Energy in MeV	Lead (Pb) Z=82	
						μ in cm^{-1}	1 TVL in cm
^{60}Co	1.25*	0.288	7.992		1.25*	0.650	3.544
^{137}Cs	0.662	0.473	4.866		0.662	1.174	1.961
^{18}F	0.511	0.621	3.710		0.511	1.637	1.406
	0.3	1.372	1.678		0.3	4.170	0.552

*arithmetic average of the 2 γ–emission lines 1.17 MeV and 1.33 MeV
All data are calculated for narrow beam geometry (primary radiation)

diagram	see annex

Reference (basic data of mass attenuation coefficients used for all elements)

Ellery Storm, Harvey I. Israel: Photon Cross Sections from 0.001 to 100 MeV for Elements 1 through 100;
Los Alamos Scientific Laboratory of the University of California; Report written: June 1967; Report distributed: November 15, 1967

7. **Annex** (diagrams, curves)

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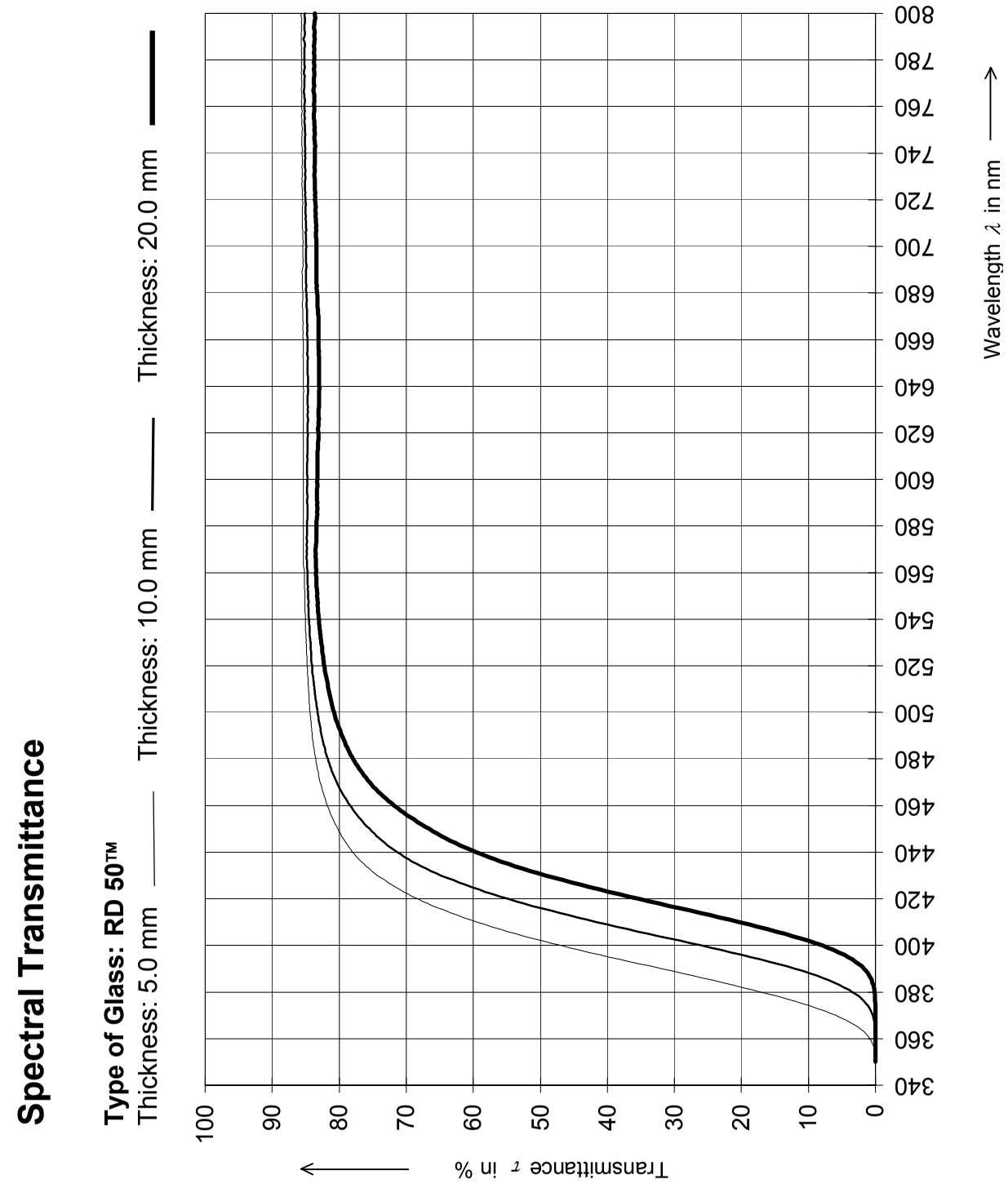

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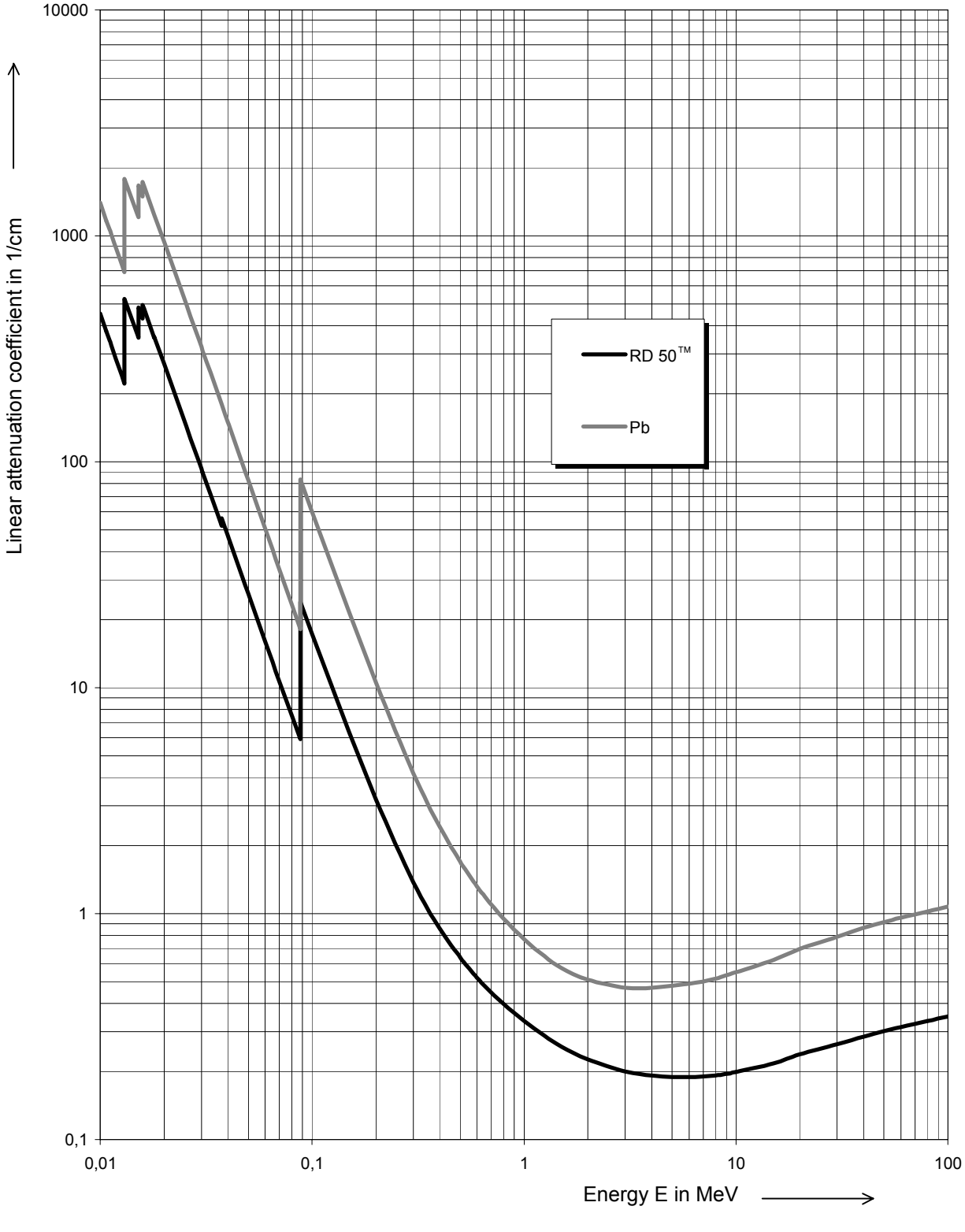
Linear attenuation coefficient



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Tenth-value layer