Ge surface cleaning

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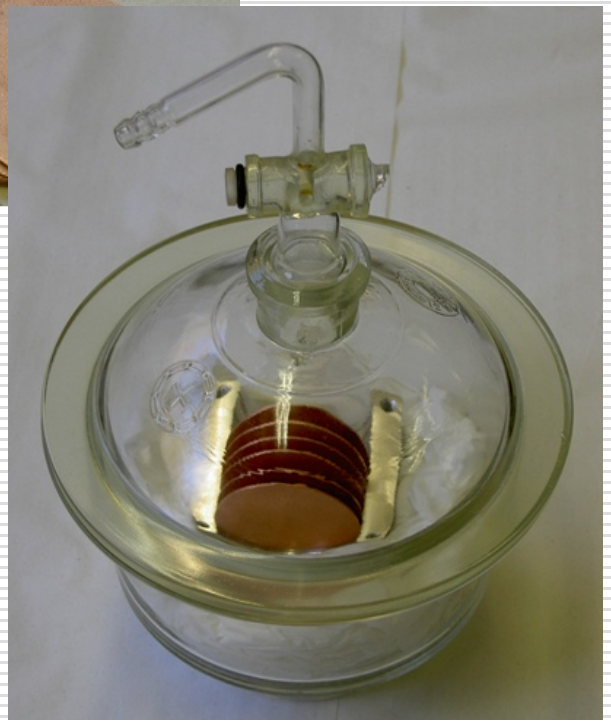
Outlook

- Applied technique for Ge cleaning
  - Loading samples with the Rn daughters
  - Investigations of ^{210}Pb/^{210}Bi/^{210}Po
- Ge surface treatment
  - Optical quality Ge
  - HPGe
  - Comparison with Copper and Steel
- Summary

Loading the samples



Discs

Filter

^{222}Rn
source
(1.4 MBq)

Pump

Measuring ^{210}Pb/^{210}Bi/^{210}Po

- Screening of ^{210}Po with an alpha spectrometer 50 mm Si-detector, bcg ~ 2 α/d (1-10 MeV) sensitivity ~ 20 mBq/m^2 (100 mBq/kg, ^{210}Po)
- Screening of ^{210}Bi with a beta spectrometer 2$\times$50 mm Si(Li)-detectors, bcg ~ 0.18/0.40 cpm sensitivity ~ 10 Bq/kg (^{210}Bi)
- Screening of ^{210}Pb (46.6 keV line) with a gamma spectrometer 16 % - HPGe detector with an active and a passive shield

Optical quality Germanium

- "Test run" before using HPGe
- Samples cut out from bigger Ge pieces, no special surface treatment after cutting
- 2 discs 50 mm in diameter and 3 mm thick were exposed for 7 months to our Rn source (1.4 MBq)
- Discs etched by Canberra according to their standard procedure applied to HPGe crystals
- Discs before/after etching were screened for ^{210}Pb/^{210}Bi/^{210}Pb

Optical quality Germanium - results

Disc No. 1

Isotope	Disc side	Initial activity [cpm]	Activity after cleaning [cpm]	Reduction factor R	Average reduction factor R_{av}	Remarks
^{210}Pb	a	2.08	< 0.02	> 104	> 104	Amount of removed Ge not measured. After etching side b not measured for ^{210}Pb.
	b	3.43	-	-		
^{210}Bi	a	42.7	< 0.18	> 237	> 427	
	b	67.9	< 0.11	> 617		
^{210}Po	a	42.4	0.04	1060	2300	
	b	71.7	0.02	3585		

Optical quality Germanium - results

Disc No. 2

Isotope	Disc side	Initial activity [cpm]	Activity after cleaning [cpm]	Reduction factor R	Average reduction factor R_{av}	Remarks
^{210}Pb	a	2.09	-	-	> 106	Amount of removed Ge not measured. After etching side a not measured for ^{210}Pb. ^{210}Bi not measured because it has decayed.
	b	2.12	< 0.02	> 106		
^{210}Bi	a	40.7	-	-	-	
	b	46.1	-	-		
^{210}Po	a	50.0	0.06	820	880	
	b	47.0	0.05	940		

Activities of all isotopes reduced significantly after etching,
^{210}Po removed most efficiently

HPGe

- Two 50 mm in diameter and 3 mm thick HPGe discs provided by MPI-M
- One disc and HP water (2 L) exposed to the strong Rn source for 9 months
- Exposed disc etched by Canberra in their standard solution, clean disc etched in a solution made with the exposed water
- Discs before/after etching screened for ^{210}Pb/^{210}Bi/^{210}Pb

HPGe discs loading

HPGe results

Exposed disc

	^{210}Po	^{210}Bi	^{210}Pb
Before cleaning	11.88 ± 0.19	14.70 ± 0.12	0.717 ± 0.011
After cleaning	0.102 ± 0.006	0.017 ± 0.008	< 0.001
Reduction factor	117 ± 7	865 ± 407	> 717

Unexposed disc

	^{210}Po	^{210}Bi	^{210}Pb
Before etching (background)	0.064 ± 0.005	0.111 ± 0.004	0.0163 ± 0.0004
After etching (average act. from both disc sides) bcg corrected!	0.023 ± 0.007	0.106 ± 0.011	0.0066 ± 0.0016
Increase above the background	~ 35 %	~ 100 %	~ 40 %

Exposed water measured with an HPGe spectrometer did not show any activity above the background (LLL in HD).

Comparison between Cu/Steel/Ge

Isotope	Average reduction factors for etching		
	Copper	Steel	Ge (Opt. – HP)
^{210}Pb	~ 50	~ 100	100 – 700
^{210}Bi	~ 50	~ 100	400 – 800
^{210}Po	~ 1	~ 20	1000 – 100

- Etching of Copper is the less effective, for Po there is no effect
- Results for Steel are acceptable, also Po has been removed
- Etching of Ge is the most efficient, surface quality seems to play a role

Summary

- Etching of opt. Ge/HPGe removes efficiently all long-lived Rn daughters
- Small quantities of ^{210}Pb/^{210}Bi/^{210}Pb found on the surface of the unexposed disc etched in the contaminated solution (the level of water contamination was unknown) - for each sample a fresh solution is required in order to avoid re-depositon
- ^{210}Po removed more efficient form optical quality Ge, ^{210}Pb/^{210}Bi from HPGe – surface quality plays a role
- Etching effectiveness in ^{210}Pb/^{210}Bi/^{210}Po removal differs for each isotope and for different materials (Cu, Steel, Ge)