Long-term measurements of radon progeny concentrations with LR 115 SSNTDs

K.N. Yu[a,*], D. Nikezic[a], F.M.F. Ng[a], B.M.F. Lau[a], J.K.C. Leung[b]

[a]Department of Physics and Materials Science, City University of Hong Kong, Tat Chee Avenue,
Kowloon Tong, Hong Kong
[b]Department of Physics, University of Hong Kong

Abstract. We proposed a method to determine the equilibrium factor using LR 115. © 2004 Elsevier B.V. All rights reserved.

1. Introduction

Methods for long-term monitoring of concentrations of radon progeny or the equilibrium factor are still being explored. The equilibrium factor is defined as $F = 0.015 F_1 + 0.515 F_2 + 0.380 F_3$ where F_1, F_2 and F_3 are the ratios of the activity concentrations of ^{218}Po, ^{214}Pb and ^{214}Bi(Po) to that of ^{222}Rn.

2. Proxy equilibrium factor measurements with LR 115

The partial sensitivities ρ_i of the bare LR 115 detector to ^{222}Rn, ^{218}Po and ^{214}Po (i.e., the number of tracks per unit area per unit exposure) were studied through Monte Carlo simulations and were found to be the same for ^{222}Rn, ^{218}Po and ^{214}Po. The total track density ρ (track/m^2) on the detector is then $\rho = \rho_i (C_0 + C_1 + C_3)t$, where C_0, C_1 and C_3 are concentrations of ^{222}Rn, ^{218}Po and ^{214}Po (Bq/m^3), and t is the exposure time. For known C_0, the proxy equilibrium factor F_p ($F_1 + F_3 = \rho/(\rho_i t C_0) - 1$) [1] is found. Equilibrium factors were calculated from the Jacobi room model [2] and plotted with F_p in Fig. 1.

---

 * Corresponding author. Tel.: +852 27887812; fax: +852 27887830.
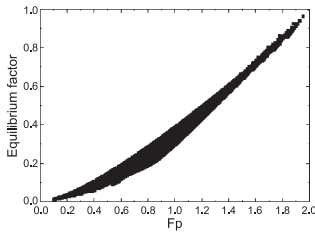 *E-mail address:* peter.yu@cityu.edu.hk (K.N. Yu).

Fig. 1. Dependence of the equilibrium factor F on the proxy equilibrium factor F_p ($F_1 + F_3$).
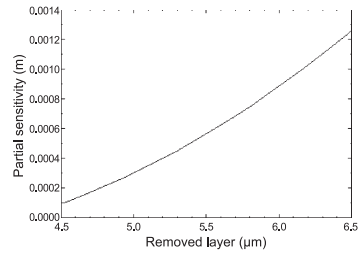
Fig. 2. The relationship between the partial sensitivity of the LR 115 detector from DOSIRAD and the removed active layer thickness.

Table 1
The partial sensitivities and track densities determined for our detectors and the derived values of F_p and F (from LR 115 detectors)

Detector	Partial sensitivity (10^{-4} m)	Track density (10^6 m^{-2})	F_p	Derived F (from LR 115)	Experimental F
1	1.960	0.124	1.80	0.83–0.88	0.76±0.14
2	3.710	0.221	1.69	0.75–0.80	0.76±0.14
3	3.108	0.171	0.81	0.18–0.31	0.21±0.06
4	3.532	0.168	0.57	0.08–0.18	0.21±0.06
5	4.625	0.245	0.54	0.07–0.17	0.13±0.04
6	3.572	0.182	0.09	0.00–0.03	0.13±0.04

The experimental values of F are also given for a comparison.

3. Experimental validation

LR 115 detectors were exposed in a radon exposure chamber and then etched in 2.5 N aqueous solution of NaOH at 60 °C under stirring. The detector thickness was measured by surface profilometry [3]. The relationship between ρ_i and the removed layer was derived for LR 115 detectors from DOSIRAD being used and shown in Fig. 2. The partial sensitivities were determined from Fig. 2. The results are shown in Table 1. The derived F_p values (from LR 115) are in agreement with the experimental values.

Acknowledgment

References

[1] D. Nikezic, F.M.F. Ng, K.N. Yu, Theoretical basis for long-term measurements of equilibrium factors using LR 115 detectors, Appl. Radiat. and Isotopes 6 (2004) 1431–1435.
[2] W. Jacobi, Activity and potential energy of ^{222}Rn and ^{220}Rn daughters in different air atmosphere, Health Phys. 22 (1972) 441–450.
[3] C.W.Y. Yip, et al., Effects of stirring on the bulk etch rate of LR 115 detector, Radiat. Meas. 37 (2003) 197–200.