



# Development and Verification of Mailed Audit Alanine Dosimeters for Radiotherapy in China

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## INTRODUCTION

One of the mission of the National Institute of Metrology (NIM) is to plan, implement and monitor the programs relating to radiation dose measurements to assure control dosages in radiotherapy and to protect the patient and the doctor. The calibration service of ionizing chambers, dosimeters, and well-type chambers for the hospitals have been carrying out for dozens of year. While the postal dose audit service was not performed in china, which is helpful for the radiotherapy quality assurance and quality control.

## AIM

To extend the absorbed dose range of alanine reference dosimeters for radiotherapy dosimetry and establish the mailed audit reference system in China, a alanine dosimeter manufactured by the NIM was characterized carefully. The reproducibility of dose, dependence of dose rate and linear dose response were measured, to confirm whether the alanine dosimeter is suitable for the radiotherapy dose measurement.

## METHOD

The alanine dosimeter with diameter of 2.8 mm - 3 mm and height of 4 mm - 7 mm was fabricated by 80% DL- $\alpha$ -alanine and paraffin. The irradiated alanine was measured by EPR, the absorbed dose was calculated by the follow formula.

$$D = \frac{S_{pp} \cdot k_{Ti} \cdot k_{Tr} \cdot c}{m}$$

- $S_{pp}$  is the "peak to peak" height from the EPR spectrum
- $k_{Ti}$  and  $k_{Tr}$  represent temperature corrections at time of irradiation and time of readout respectively
- $m$  is the mass of the dosimeter
- $c$  is a constant that converts from spectrum output to  $E_{dep}$

## RESULTS

The national institute of metrology of China has alanine absorbed dose standard in the range of (0.1-40) kGy with uncertainty of 4.0% ( $k=2$ ) used for industry applications. To carry out the postal dose audit service for radiotherapy, with the updating of the fabrication and measurement setup for the alanine dosimeter, and the background subtraction and dosimetry calibration, the dose of alanine dosimeter (2.8mm in height and 4.3 mm in diameter) can come to lower than 10 Gy.

The alanine dosimeter at the range of 2 Gy to 100 Gy, with the linearity of 0.99999, can give the typical precision of  $\pm 1\%$  at  $1\sigma$ . The temperature dependence of the dosimeters from 20 °C to 25 °C is within 0.7%, and the repeatability is within 0.5%. The directional response and longtime stability were also investigated. The combined standard uncertainty of the alanine dosimeter for radiotherapy dose level is 2.0 % and can to be used for radiotherapy dose measurement.

Comparing the ion chamber and mailed alanine dosimeter in the hospitals, the water absorbed dose measured by different dosimeters was agreed better than 1% at 10 MV photon beams.



Fig 1. The alanine dosimeter, the  $^{60}\text{Co}$  reference radiation field and the EPR.

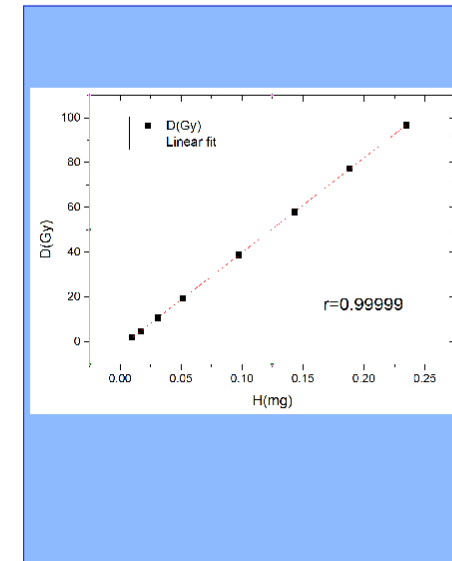


Fig 2. The linearity of dose of the alanine dosimeter with the range 2 Gy to 100 Gy.

Tab 1. The reproducibility of dose and precision of the alanine dosimeter.

No.	Dose	1	2	3	4	Average	SD	RSD
6#	1.934	39.2642	39.3276	38.9368	39.1832	39.1779	0.1712	<b>0.004</b>
5#	4.835	34.0046	34.1822	34.2572	34.6970	34.2852	0.2942	<b>0.008</b>
4#	10.637	24.6166	24.5941	24.7187	25.1262	24.7514	0.2475	<b>0.010</b>
2#	19.341	25.8488	25.6504	25.7634	25.7503	25.7532	0.0812	<b>0.003</b>
3#	38.682	38.8339	38.8871	38.9595	38.9183	38.8997	0.0529	<b>0.001</b>
1#	58.023	28.7843	28.6738	28.648	28.5973	28.6759	0.0789	<b>0.002</b>
8#	77.364	30.1035	30.2253	29.9992	30.0439	30.0930	0.0980	<b>0.003</b>
7#	96.705	23.4855	23.4911	23.5075	23.4583	23.4856	0.0250	<b>0.001</b>

Tab 2. The directional response during the reading by the EPR.

Direction	1	2	3	4
I	1850	1862	1853	1853
II	1865	1861	1874	1856
III	1873	1884	1879	1866
IV	1866	1870	1870	1842
Mass (mg)	64.74	65.19	65.24	64.84
Average (Gy)	<b>28.784</b>	<b>28.674</b>	<b>28.648</b>	<b>28.597</b>

## CONCLUSIONS

Alanine dosimeter can be used to a range of radiation therapy beams, such as absolute dosimetry, dose verification, and end to end dosimetry. The accurate of alanine at better than 1% for mailed audit dosimeters was verified for 10 MV photon beams in China.

## ACKNOWLEDGEMENTS

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## CONTACT INFORMATION

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