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Author
Henson, Anna M.

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Anna M. Henson and Ralph H. Thomas

June 15, 1977

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MEASUREMENTS OF THE EFFICIENCY OF $^7$LiF
THERMOLUMINESCENT DOSIMETERS TO HEAVY IONS

Anna M. Henson and Ralph H. Thomas
Lawrence Berkeley Laboratory
University of California
Berkeley, California  94720

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Introduction

We continue to accumulate the necessary experimental data to facilitate
reliable and flexible heavy-ion dosimetry.

In a previous paper measurements of the efficiency, $\varepsilon$, of $^7$LiF
thermoluminescent dosimeters (TLD's) relative to $^{60}$Co, to $^{6}$C, $^{8}$O, and
Ne$^{+10}$ ions in the energy range 250-1050 MeV/amu have been reported (Sm 77).

This note reports measurements of the efficiency of $^7$LiF TLD's to
798 MeV/amu $^1$H and 447 MeV/amu $^{18}$A ions.

Experimental Technique

The experimental technique used has been described in detail elsewhere
(Sm 77). Briefly, the heavy-ion fluence incident upon the dosimeters, $\phi$,
is determined by nuclear emulsion or other visual techniques, or by activa-
tion detectors. The absorbed dose in the irradiated dosimeters may then
be calculated from their known stopping power, $(dE/dx)_{LiF}$, for the incident
ions. Finally, the dosimeter response to heavy ions, $L$, is compared with
the dosimeter response to $^{60}$Co photons for an exposure of 1 roentgen, $\tau$.

It may then be readily shown that:

$$\varepsilon = \frac{5.025 \times 10^{-7}}{\tau(dE/dx)_{LiF}} \cdot (\frac{L}{\phi})$$  \hspace{1cm} (1)

In the work reported here, $^7$LiF TLD's were irradiated by 798 MeV
protons (798 MeV/amu $^1$H ions) and by 447 MeV/amu $^{18}$A ions. The incident
proton fluence was determined by measuring the production of $^{11}$C in
polystyrene (Ca 76). The incident argon ion fluence was determined by
scanning Kodak Type NTA film (He 76). The results obtained were
$\varepsilon = 1.08 \pm 0.08$ and $0.523 \pm 0.021$, respectively.
Summary and Conclusions

Table 1 summarizes all the measurements of $\epsilon$ reported to date by our group.

Table 1. Measurements of $\epsilon$

<table>
<thead>
<tr>
<th>Ion Species</th>
<th>Energy (dE) in MeV/amu</th>
<th>$(\frac{dE}{dx})$ in $^7$LiF MeV g$^{-1}$ cm$^2$</th>
<th>$\epsilon$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$H^+$</td>
<td>798</td>
<td>1.89</td>
<td>1.08 $\pm$ 0.08</td>
</tr>
<tr>
<td>$C^{+6}$</td>
<td>252</td>
<td>116</td>
<td>0.89 $\pm$ 0.02</td>
</tr>
<tr>
<td>$O^{+8}$</td>
<td>300</td>
<td>112</td>
<td>0.90 $\pm$ 0.05</td>
</tr>
<tr>
<td>$O^{+8}$</td>
<td>1050</td>
<td>186</td>
<td>0.82 $\pm$ 0.05</td>
</tr>
<tr>
<td>$Ne^{+10}$</td>
<td>372</td>
<td>259</td>
<td>0.73 $\pm$ 0.05</td>
</tr>
<tr>
<td>$A^{+18}$</td>
<td>447</td>
<td>770</td>
<td>0.52 $\pm$ 0.02</td>
</tr>
</tbody>
</table>

The two new values of $\epsilon$ reported here are consistent with our previous measurements and those of Jähnert (Ja 72). The value of $\epsilon$ measured for protons of 1.08 $\pm$ 0.08 is consistent with the expected value of 1.0 within the experimental accuracy of the determination. The rather large area is due to some uncertainties in the beam distribution used during the measurement (Ca 76). Measurements of $\epsilon$ in the energy loss region of $\sim$10 MeV g$^{-1}$ cm$^2$ and $\sim$2000 MeV g$^{-1}$ cm$^2$ are now needed.

Acknowledgments

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References


He 76  Henson, A.M. and Thomas, R.H., 1976, The Efficiency of $^7$LiF Thermoluminescent Dosimeters to 447 MeV/amu $^{18}$Ions, Relative to $^{60}$Co Photons. Lawrence Berkeley Laboratory Health Physics Department internal memorandum HPN #58, December 7, 1976 and Addendum March 31, 1977.


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