

(n,γ)

**Tris (2,2,6,6-tetramethyle-3,5-heptanedionato)
Holmium (III)**

(3)

(2)

(1)

(3)

(1)

(2)

2010/09/27

2011/05/02

 $^{165}\text{Ho}(n,\gamma)^{166}\text{Ho}$ ^{166}Ho

Tris (2,2,6,6-tetramethyle-3,5-heptanedionato) Holmium(III)

. -1

. -2

 1×10^{12} . % 45 ^{166}Ho

:

Hot Atom Reactions Resulting From (n, γ) in Holmium Compound Tris (2,2,6,6-tetramethyle-3,5-heptanedionato) Holmium(III)

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ABSTRACT

The behavior of a recoiled ^{166}Ho resulting from the reaction $^{165}\text{Ho}(n,\gamma)^{166}\text{Ho}$ in the compound Tris (2,2,6,6-tetramethyle-3,5-heptanedionato) Holmium(III) was investigated. Irradiation was carried out in a low flux research reactor (the Syrian Miniature Nuclear Source Reactor MNSR) with a maximum thermal neutron flux of $1 \times 10^{12} \text{ n.cm}^{-2}.\text{s}^{-1}$. Chemical separation methods were developed to separate the recoil product from the irradiated compound. It was found that the paper chromatography gave the best results where the compound was developed with toluene. The study showed that the retention value of holmium ^{166}Ho was equal to 45%. It was also found that the process of purification and the irradiation of samples in an inert atmosphere had a neglected impact on the retention value of the studied compound. This was attributed to the presence of oxygen in the structure of the molecule, where it is released during the nuclear recoil process and play scavenger role.

Key words: Hot atom reactions, Holmium, Retention, Extraction, Column chromatography, Thin layer chromatography, Paper Chromatography, Gamma spectrometry, Beta scanner, Liquid scintillation counter.

.1

[Knapp Jr.F.F.,

2005]

1970 – 1955

73

278

.[IAEA,2003]

.[Yassine T., 1987]

 ${}^A X(n, \gamma) {}^{A+1} X^*$

.[Nesmeyanov An. N., 1974]

.[Yassine T., 1987]

.[Nesmeyanov An. N.,1974]

$$R = \frac{A_{org}}{A_{org} + A_{inorg}} \quad (1)$$

¹⁶⁶Ho

[Han H.S., 2003] [IAEA,2003]

1998

x¹⁶⁶Ho³⁺

¹⁶⁶Ho³⁺

(HPLC)

2,2-bipyridyl Acetylacetonate 4-aminobenzoate

¹⁶⁶Ho

thiocyanate

%45 4-aminobenzoate

%48

.2,2-bipyridyl thiocyanate

%26

Acetylacetonate

[Zeisler S.K., 1998]

.2

Tris (2,2,6,6-tetramethyle-3,5-heptanedionato) Holmium (III)

Specific Activity

¹⁶⁶Ho

Improvement

MNSR

¹⁶⁶Ho-DTPA

¹⁶⁶Ho- DOTMP

¹⁶⁶Ho-FHMA

¹⁶⁶Ho-EDTMP

¹⁶⁶Ho-MA

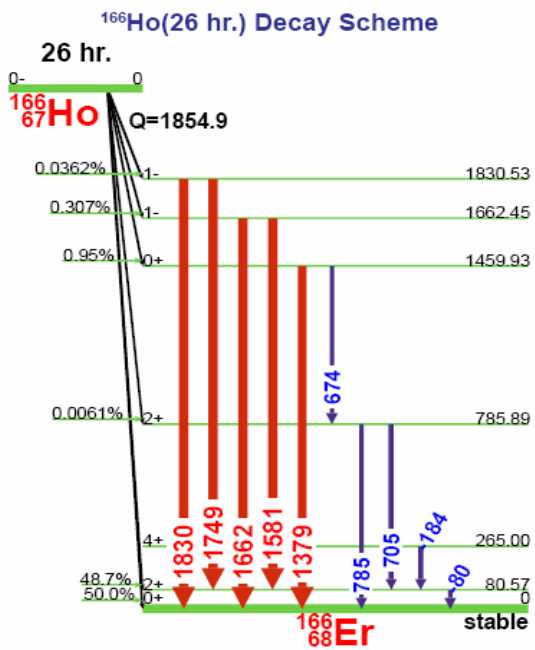
¹⁶⁶Ho-chitosan

3.3 mm

26

(1)

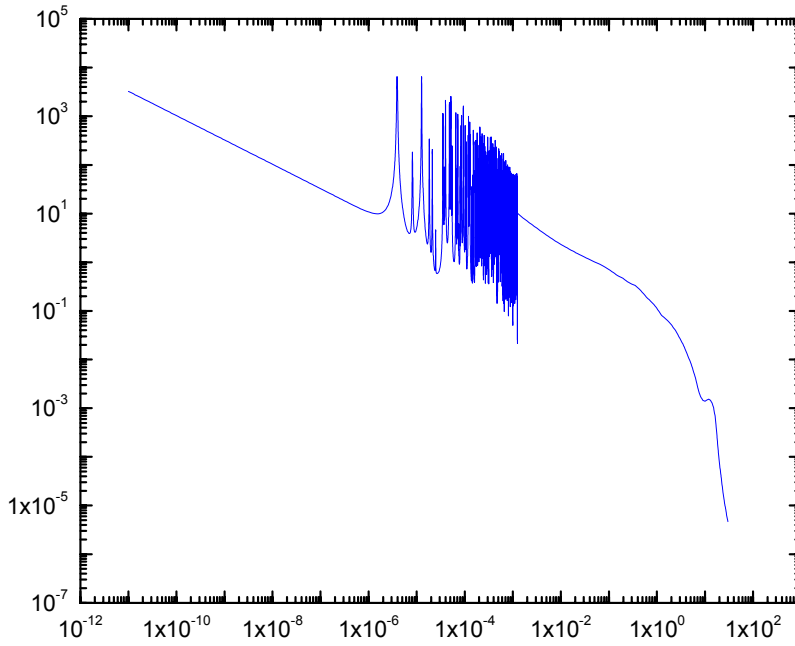
(barns)
MNSR
(2)



.keV

[GRSC, 1998] ¹⁶⁶Ho

(1)



.[ENDF] ¹⁶⁵Ho

(2)

.3

3.1

Organometallic Compound

[Komiya S., 1997]

Isotopic

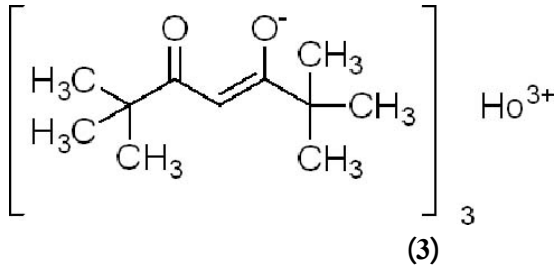
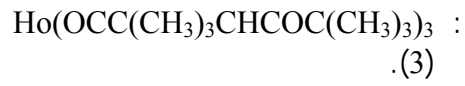
Exchange

[Nesmeyanov An. N., 1974]

[Samonov A. M., 1987]

AlfaAesarGmbH & CoKG

% 99.99

MgSO₄

MNSR

3.2

Low Power

Tank-in-Pool

MNSR

Research Reactor

30

·⁻¹ ·⁻²·1×10¹²
()·⁻¹ ·⁻²1 × 10¹²

50

1×10¹¹

... (n, γ)

(84) 45 1- -2

90

8 2 0.1 10 2

24

15 ^{24}Na

3.3

Extraction :

Column Chromatography

Thin Layer Chromatography

SiO₂ 250

Paper Chromatography

.whatman. Chr.4 whatman Chr.1

3.4

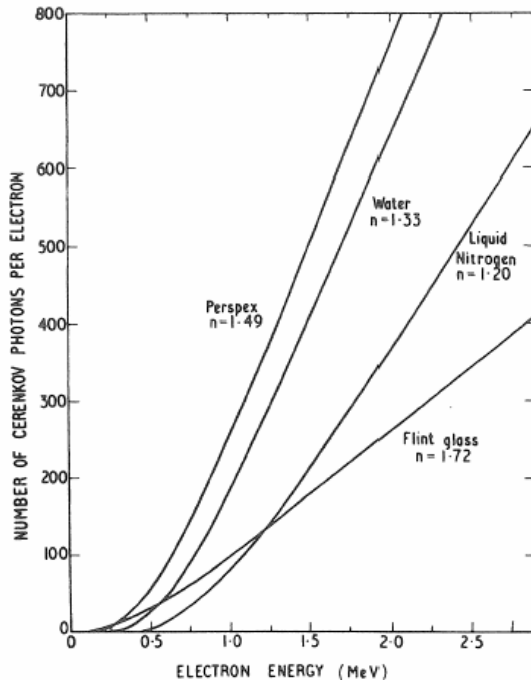
Beta Gamma ^{166}Ho

(1)

500 keV Cerenkov

MeV 280 ^{166}Ho

[Glenn (4) Perspex .F.Knoll, 1979]



MeV

(4)

Gamma spectrometry

%40 %25)

25%

(%60

1397

.(0.93%)

122 keV
keV

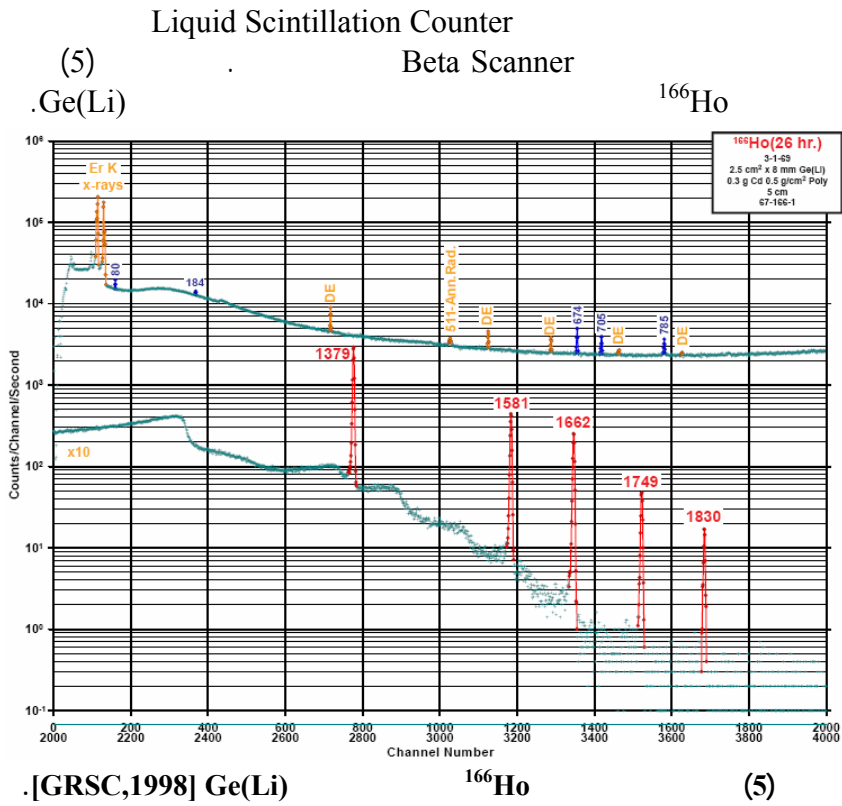
80 keV

%60

1keV

.(%6.71)

NaI



.4

(6)

End of irradiation

6.5 3.3

16

1379 keV

.%40

:

[SAR, 1993] %3

(650 ± 22)

. [Mednis I.V., 1991]

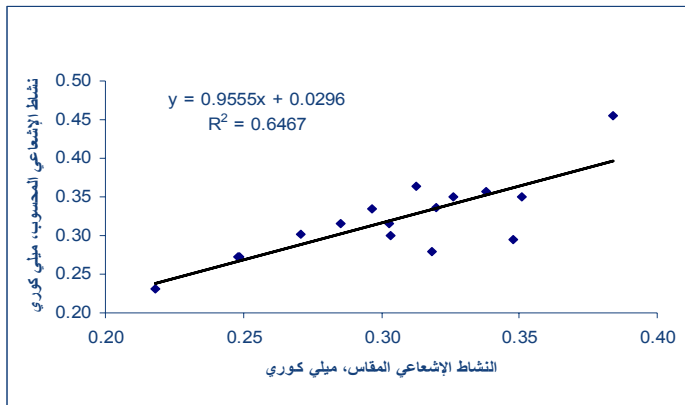
(1)

(0.05 M)

HoCl₃

1379 keV

.%40



(6)

...

(n, γ)

.% (2.9 \pm 0.2)

(1)

%	/						
3.3 \pm 0.2	6.7	2392		50	6.4	1	1
	0.2	1345					
2.9 \pm 0.1	36.8	16357		50	4.7	1	2
	1.1	1719					
3.1 \pm 0.2	28.7	19027		24	5.2	2	3
	0.9	560					
3.2 \pm 0.1	35.1	23766		19	6.5	2	4*
	1.2	695					
3.5 \pm 0.2	30.6	20421		22	5.1	2	5
	1.1	677					
3.3 \pm 0.2	23.6	15289		21	5.1	2	6*
	0.8	485					
1.9 \pm 0.1	18.4	11755		24	3.9	2	7
	0.4	212					
2.4 \pm 0.2	13.0	8119		39	5.4	1	8
	0.3	193					
2.7 \pm 0.2	12.2	7618		41	5.8	1	*9
	0.3	206					

(2)

1379 keV
 .% 40

*

*

(2)

%	/				
1.6 ± 0.2	20.60	3.40E+05	7.01E+06		1
	6.70	9.58E+04	2.22E+06		
	8.21	1.23E+05	2.86E+06	HCl(1M) 1	
	0.30	9.11E+03	9.48E+04	1 -(3)	
	0.03	2.39E+03	9.94E+03	2 -(2)	
	-	-	-	3 -(2)	
2.3 ± 0.2	21.82	3.38E+05	7.43E+06		2
	6.61	1.17E+05	2.32E+06		
	7.03	1.31E+05	2.69E+06	HCl(1M) 1	
	0.35	5.45E+04	1.21E+06	1 -(3)	
	0.11	5.00E+03	3.92E+04	2 -(2)	
	0.05	3.12E+03	1.60E+04	3 -(2)	
4.2 ± 0.3	23.71	3.95E+05	8.25E+06		3
	6.52	1.24E+05	2.49E+06		
	7.21	1.29E+05	2.80E+06	HCl(1M) 1	
	0.81	1.70E+04	2.81E+05	1 -(3)	
	0.11	5.02E+03	3.90E+04	2 -(2)	
	0.08	4.45E+03	2.86E+04	3 -(2)	
	-	-	-	4 -(2)	
	-	-	-	5 -(2)	
5.0 ± 0.2	21.52	3.52E+05	7.48E+06		4
	6.54	1.24E+05	2.64E+06		
	1.07	2.69E+04	4.36E+05	1 -(7)	
	-	-	-	2 -(2)	
	-	-	-	3 -(2)	

1

5

1379 keV
%40

%40

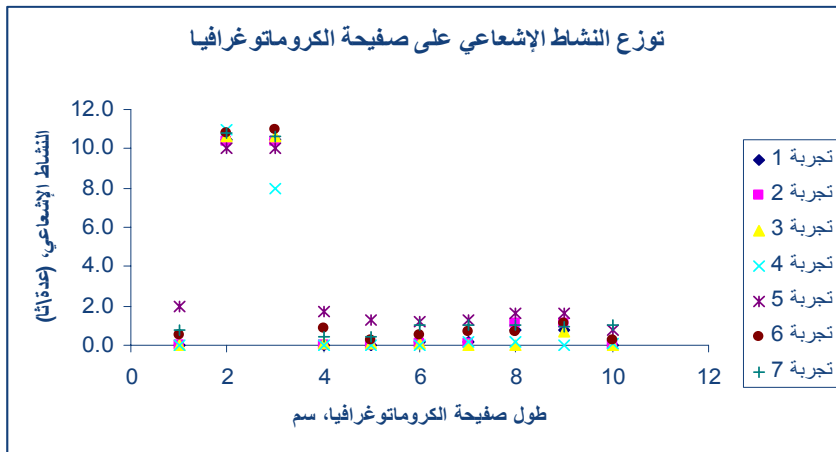
NaI

1379 keV

(7)

NaI

1



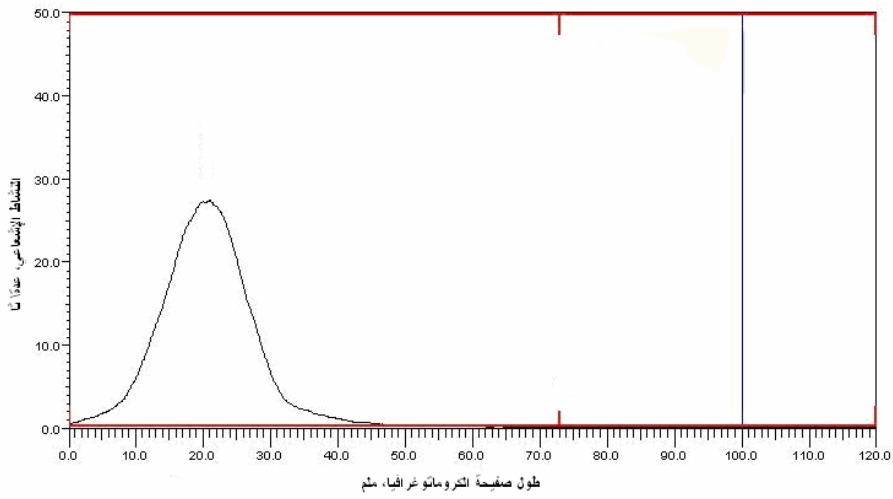
(7)

.NaI

Gamma scanner

(8)

1



(8)

1379 keV

%60
%20

1 keV
120 keV
81 keV

%6.7

1379 keV

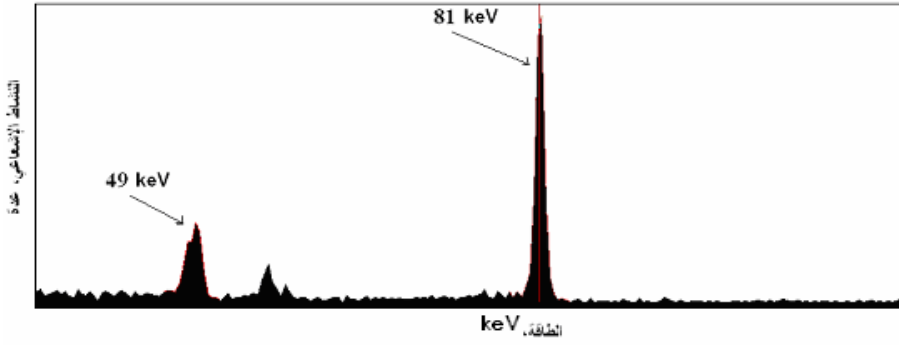
81 keV

49 keV

¹⁶⁶Ho

(9)

.keV



% 60

HPGe

¹⁶⁶Ho

(9)

(3)

81 keV

.%60

/

()

FWHM

keV

(3)

%	/	%	/	keV	%				
0.001	0.5	0.1	0.2	0.8	8.1	25	307		* 1
	59680	10.6	831	1.2	0.4	321	83137		
0.001	0.4	0.1	0.1	1.0	8.6	23	269		2*
	49801	8.5	660	1.1	0.4	285	66016		
0.001	0.4	0.1	0.1	0.9	9.3	23	247		3
	61921	10.4	814.9	1.1	0.4	317	81485		
0.001	0.6	0.1	0.2	0.9	7.2	28	387		4
	54165	9.1	710	1.1	0.4	295	71017		
0.001	1.7	0.1	0.5	1.0	3.8	38	996		5
	132427	23.1	1724	1.4	0.3	478	172406		

. %13

%(45± 8)

(4)

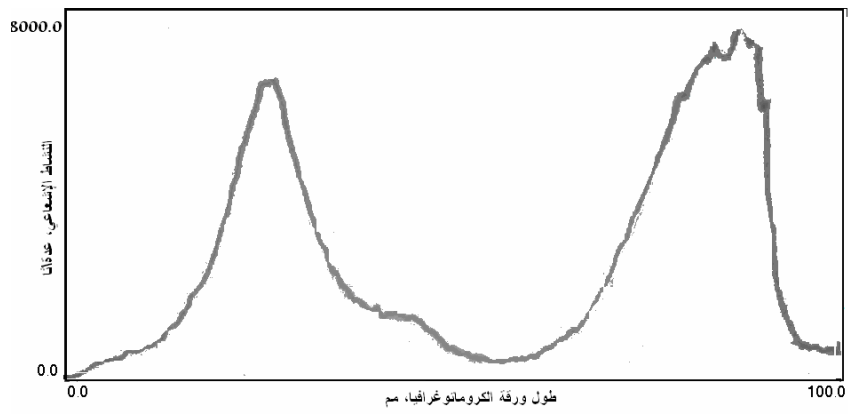
.whatman Chr.4 whatman Chr.1

*

(4)

%	/	/	
57	1656711	938203	1
57	1044568	596601	2
33	1028240	341142	3
51	1676089	850796	4
59	2019742	1190558	5
41	2120224	873856	6
41	2255207	921468	7
36	2250318	820664	8
37	2057684	760016	9
46	1901044	878863	10
55	1575703	873662	11
49	1524188	747182	12
38	1904941	722128	13
37	1715387	636993	14
35	2327033	805135	15
35	1232349	436726	16
35	1201791	416381	17
37	1006162	376546	18
57	3030842	1721012	19
34	2154173	721888	20
43	2500363	1067415	21
41	2721110	1104036	22
54	1444526	775240	23
46	1342884	619570	24
54	1589499	860867	25
43	1085292	465683	26
44	1221610	536576	27
48	714022	344100	28
57	1390077	794390	29
36	1018000	366389	30
44	1054750	469298	31
45			

(10) (%10 90%)
100.0 0.0
8000.0 0.0



(10)

.5

(11) 3 5 1
449 3 1
360.5 449
3 .(12)
.(13) 449

315.5

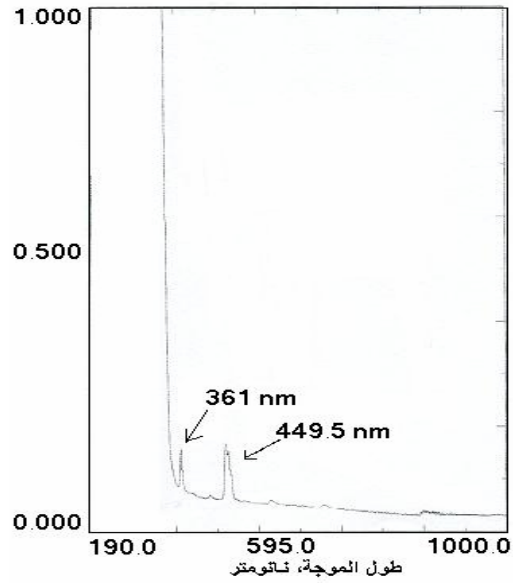
(14)
[Jan Rydberg, 1992]

.() ()
(15)

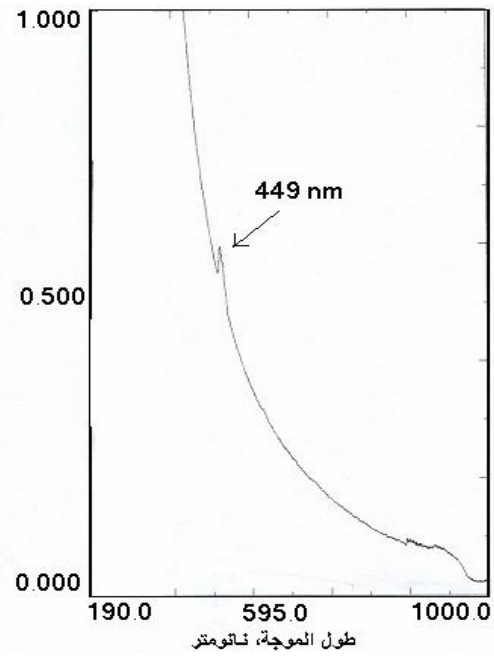
640.5 536.5 485 452 416.5 :
.(16)

.[Wiles D.R.,1973]

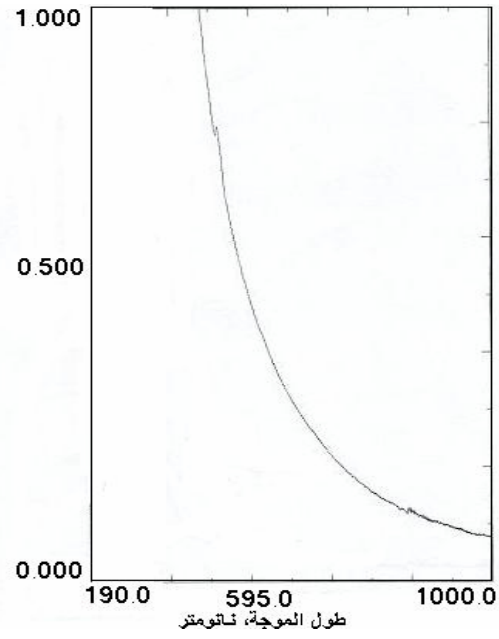
(11)
3



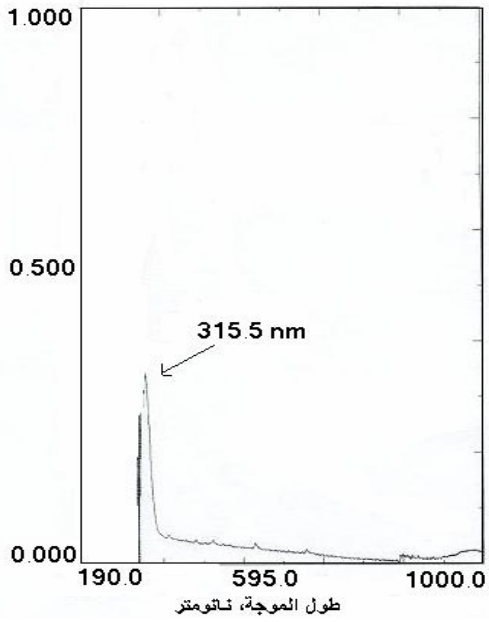
(12)
3
1



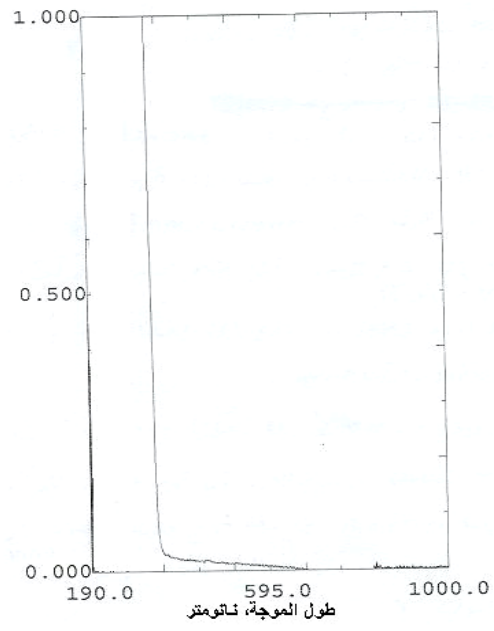
(13)
3
3
.



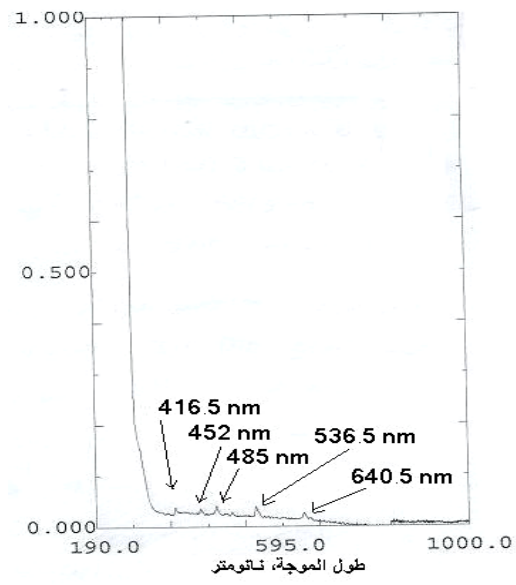
(14)
3
3
100
(0.05M)



(15)



(16)



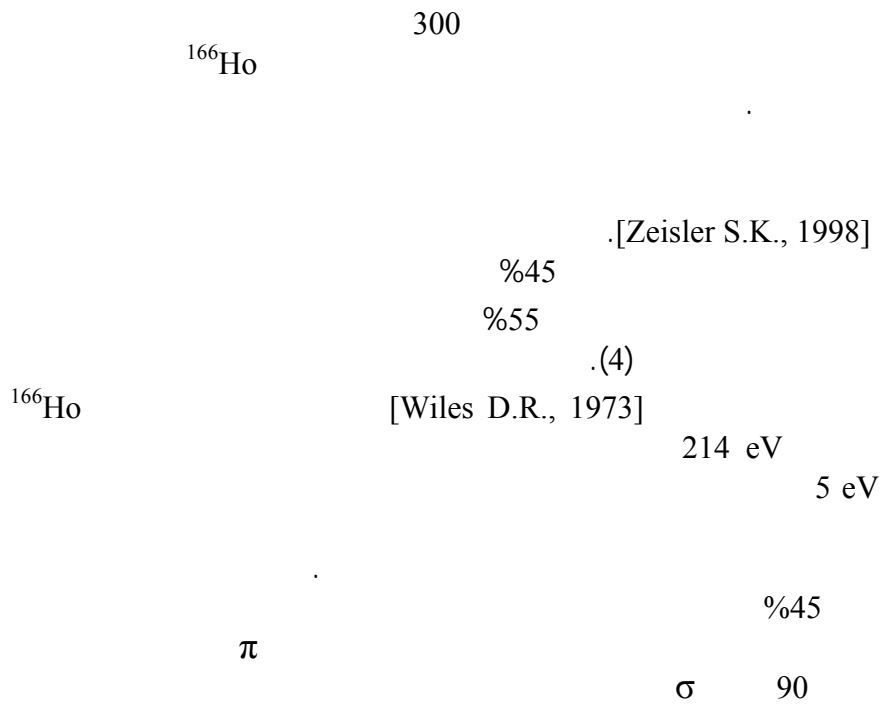
:

7 5

whatman Chr.1

whatman Chr.4

whatman Chr.4



[Wiles D. R., 1973]

[3]

...

(n, γ)

. [1]

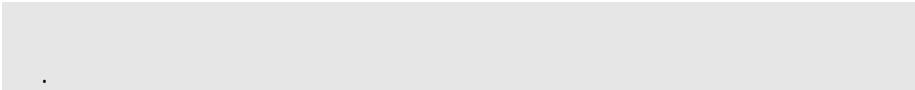
.6

MNSR
Tris (2,2,6,6-tetramethyle-3,5-heptanedionato)

Holmium (III)

%45

.7



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