INITIAL MEASUREMENTS OF YIELDS FROM A FIBROUS URANIUM CARBIDE TARGET

D. W. Stracener, K. Tsukada,[1] H. K. Carter,[2] G. D. Alton,
J. C. Batchelder,[2] J. Kormicki,[3] K. S. Toth, R. F. Welton

Using the capabilities of the UNISOR separator, we have begun the on-line development of neutron-rich radioactive beams produced as fission fragments from protons incident on a uranium carbide target. The initial tests were done using our standard electron-beam-plasma (EBP) ion source[4] with a high permeability target consisting of a 12 μm layer of uranium carbide deposited on a reticulated vitreous carbon (RVC) matrix. The target contained 3.5 g of uranium with a density of 1.2 g/cm^3 while the density of the RVC matrix itself is 0.06 g/cm^3. The target was used for several days at temperatures up to 2100^o C and appeared to be unchanged when observed after the experiment. Further tests are planned in the near future to determine the durability of this target material when irradiated with high-intensity proton beams.

During this initial test we extracted positive ions of neutron-rich isotopes of 22 elements in the mass range of 69 to 142 amu. The measured yields are listed in the table below and are given as the number of ions extracted per second per microampere of incident protons. The independent production rates from proton-induced fission were calculated using empirical fits to measured data for proton beams with energies from 10 to 40 MeV.[5-8] In these tests the production beam was 15 nA of 30 MeV protons from the HRIBF tandem accelerator. The production rates for most of the isotopes shown here will increase by a factor of two to three when the proton energy is increased to the normal operating energy of 45 MeV.

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[1] Japan Atomic Energy Research Institute, Tokai-mura, Ibaraki, Japan.
[2] Oak Ridge Institute for Science and Education, Oak Ridge, TN.
[3] Vanderbilt University, Nashville, TN.

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Ion Yields Measured at UNISOR with UC Target and EBP Source

Element	Mass	Half-life		Independent Production Rate (pps / μA)	Measured Yield (ions/sec/μA of protons)
Cu	69	2.85	m	1.40E+05	1.21E+05
	73	3.9	s	4.15E+05	2.37E+04
Zn	73	24	s	1.30E+06	1.60E+05
	74	1.6	m	1.65E+06	4.44E+05
	75	10.2	s	1.50E+06	2.69E+05
Ga	74	8.1	m	1.50E+06	4.50E+05
	75	2.1	m	3.05E+06	5.57E+05
	79	2.85	s	1.85E+06	4.34E+05
Ge	75	1.38	h	8.50E+05	8.88E+05
	79	39/19	s	1.20E+07	4.03E+05
	80	29.5	s	1.00E+07	7.82E+05
	81	7.6	s	6.50E+06	1.29E+05
	82	4.6	s	2.80E+06	4.69E+03
As	80	15.2	s	2.00E+07	1.96E+06
	81	33.3	s	2.70E+07	3.57E+05
	82	13.7	s	2.60E+07	6.18E+03
Se	84	3.2	m	5.50E+07	3.64E+05
Br	84	6/31.8	m	4.80E+07	2.25E+07
	87	55.9	s	1.00E+08	7.02E+06
	88	16.4	s	6.50E+07	9.58E+05
	90	1.92	s	1.35E+07	3.13E+06
Kr	84	stable			
	87	1.27	h	1.20E+08	1.33E+07
	88	2.84	h	1.70E+08	3.17E+06
	90	32.3	s	1.75E+08	2.87E+07

Element	Mass	Half-life		Independent Production Rate (pps / μA)	Measured Yield (ions/sec/μA of protons)
	91	8.6	s	9.50E+07	5.55E+06
	92	1.84	s	3.55E+07	9.67E+04
	93	1.29	s	1.00E+07	2.11E+04
Rb	90	2.6	m	3.10E+08	1.43E+07
	91	58.0	s	3.65E+08	6.41E+07
	92	4.48	s	3.05E+08	9.58E+05
	93	5.85	s	1.85E+08	4.59E+04
	94	2.71	s	8.00E+07	4.65E+05
Sr	93	7.41	m	4.80E+08	4.26E+05
	94	1.25	m	4.65E+08	2.81E+06
Pd	114	2.48	m	3.80E+08	8.81E+05
Ag	114	4.6	s	1.20E+08	2.06E+07
	119	2.1	s	2.65E+08	6.30E+06
	120	1.23	s	1.70E+08	3.74E+06
Cd	119	2.20/2.69	m	2.90E+08	2.14E+07
	121	8	s	3.65E+08	3.23E+06
	123	1.82	s	2.05E+08	1.26E+06
In	119	2.3	m	4.35E+07	7.32E+06
	120	46.2	s	1.05E+08	8.33E+06
	121	228/23	s	2.00E+08	2.73E+07
	123	5.98	s	4.10E+08	3.42E+07
Sn	123	40.1	m	1.10E+08	6.91E+07
	130	1.7/3.72	m	1.30E+08	2.77E+06
	132	39.7	s	1.00E+07	8.08E+05
Sb	130	6.3/39.5	m	6.00E+08	2.32E+07
	132	2.8/4.2	m	2.20E+08	1.14E+07
	133	2.5	m	8.50E+07	3.55E+06
Te	132	3.20	d	6.50E+08	1.68E+08

Element	Mass	Half-life		Independent Production Rate (pps / μA)	Measured Yield (ions/sec/μA of protons)
	133	12.5	m	5.50E+08	4.22E+07
	136	17.5	s	4.50E+07	9.42E+05
I	132	2.29	h	2.70E+08	7.75E+07
	133	20.8	h	4.90E+08	1.98E+08
	136	47/83	s	4.30E+08	8.14E+06
	137	24.5	s	2.15E+08	7.11E+06
	139	2.3	s	2.00E+07	2.60E+04
Xe	132	Stable			
	137	3.82	m	6.00E+08	2.26E+07
	139	39.7	s	2.75E+08	6.72E+06
	140	13.6	s	1.15E+08	1.28E+06
	141	1.72	s	3.75E+06	7.48E+03
Cs	139	9.3	m	5.00E+08	2.88E+06
	140	1.06	m	4.65E+08	2.37E+06
	141	24.9	s	3.05E+08	1.84E+05
	142	1.7	s	1.45E+08	5.08E+04
Ba	141	18.3	m	3.70E+08	2.30E+05
	142	10.7	m	3.85E+08	1.21E+06
La	142	1.54	h	1.40E+08	3.47E+05