Evaluation of the Claim of Transmutation of Cesium to Praseodymium with the Mitsubishi Heavy Industries (MHI) Structure – Part 1

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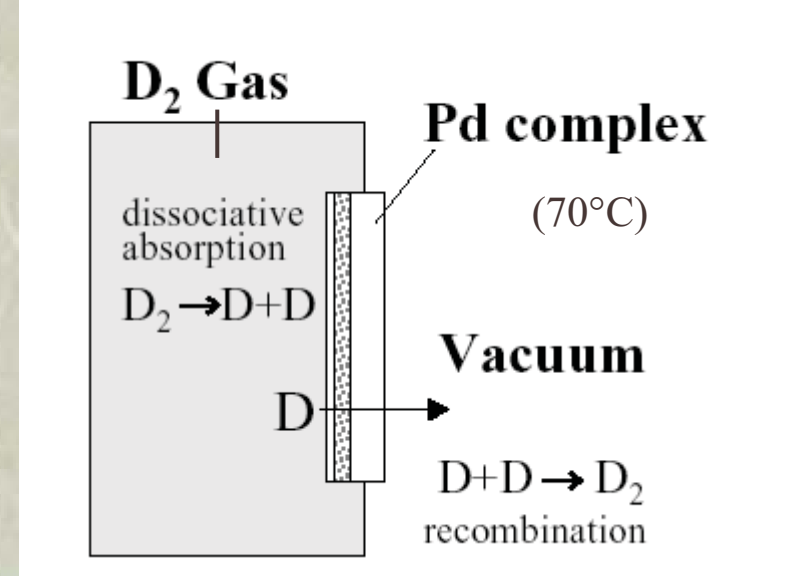
Summary of MHI Claims

- By permeating Deuterium though a Pd complex foil, various elemental transmutations can be made to happen
  - Reported transmutations:
    - $^{88}Sr \rightarrow {}^{96}Mo$ Addition of 4D
    - $^{133}Cs \rightarrow {}^{141}Pr$ Addition of 4D
    - $^{137}Ba \rightarrow {}^{149}Sm$ Addition of 6D



Elemental Analysis of Pd Complexes: Effects of D_2 Gas Permeation
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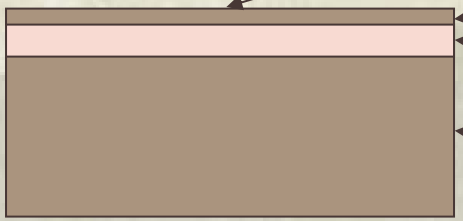
Jpn. J. Appl. Phys. Vol. 41 (2002) pp. 4642–4650

Pd complex used



25 mm x 25 mm

Thin Cs seed layer on surface

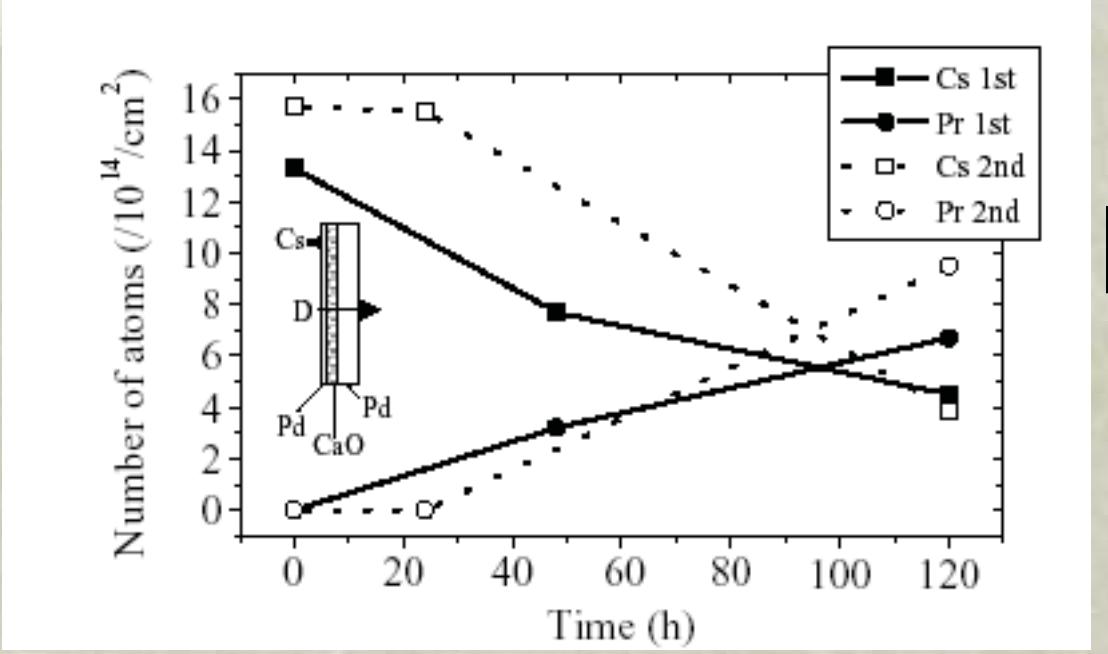
40 nm - Pd Cap Layer
100 nm total - 5 x (2 nm CaO / 18 nm Pd)

100 μm - Bulk Pd

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Cross section TEM of Pd Complex,
Y. IWAMURA, et al., Proc. ICCF-10, Cambridge MA 2003

Apparent transmutation of Cs into Pr observed by XPS



$1x10^{15}$ Pr = 235 ng

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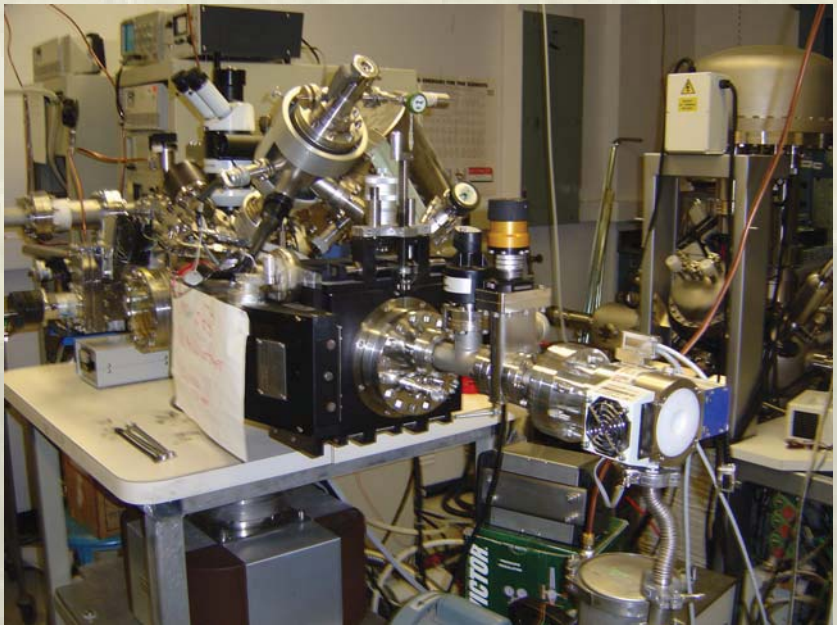
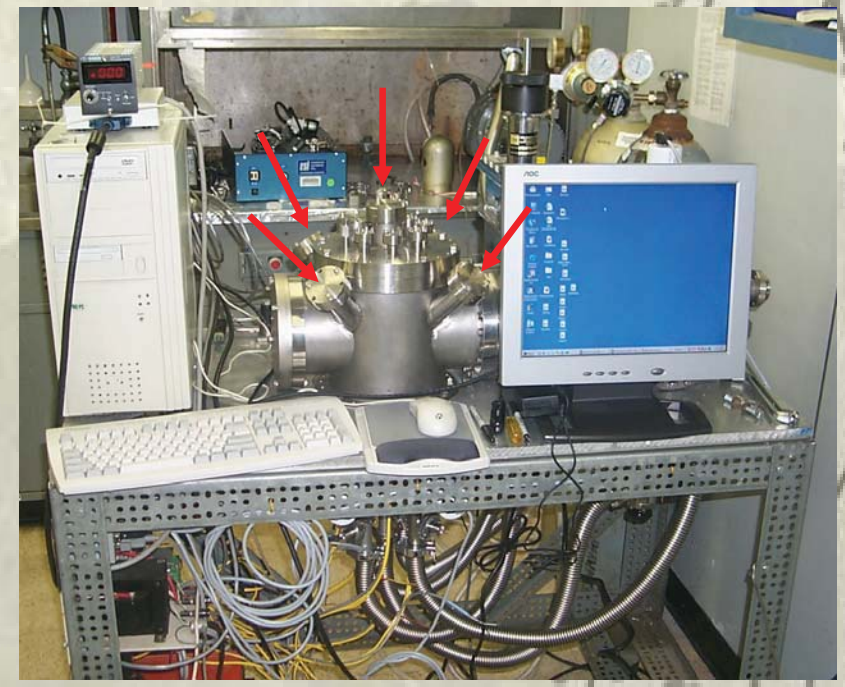
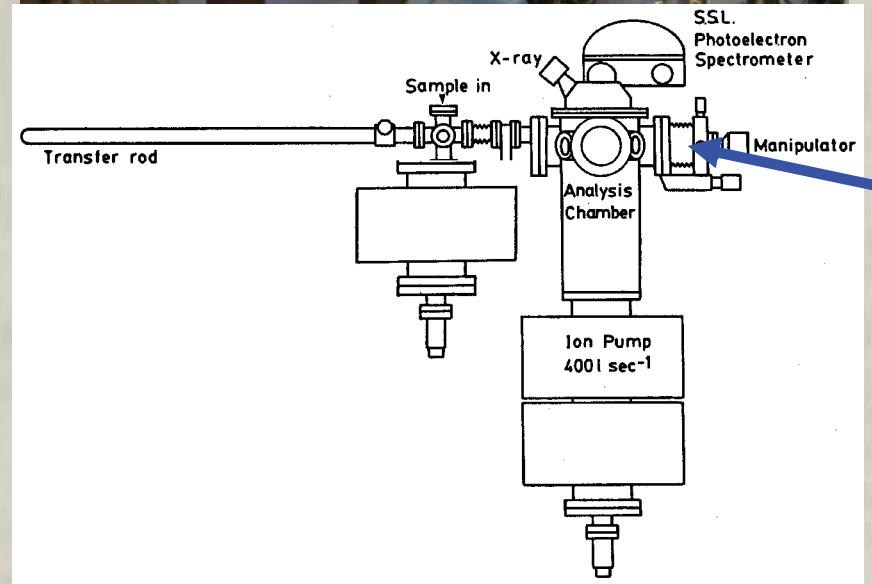
NRL Research Effort

- Collaborated with MHI to verify Pr present on their permeated samples
  - Initially with Accelerator Mass Spectrometry
  - Eventually with ICP-MS
  - NRL convinced Pr was present on some samples
- NRL attempted to independently reproduce result
  - Modified XPS instrument to enable permeation of Pd sample
  - Built 5-sample chamber with line-of-site view of sample
  - Developed Pd-complex fabrication capability
  - Pd complex structures would not permeate sufficient D
  - Unsuccessful at producing Pr
- Therefore, performed joint research with MHI

Modified XPS and 5-Sample Chambers



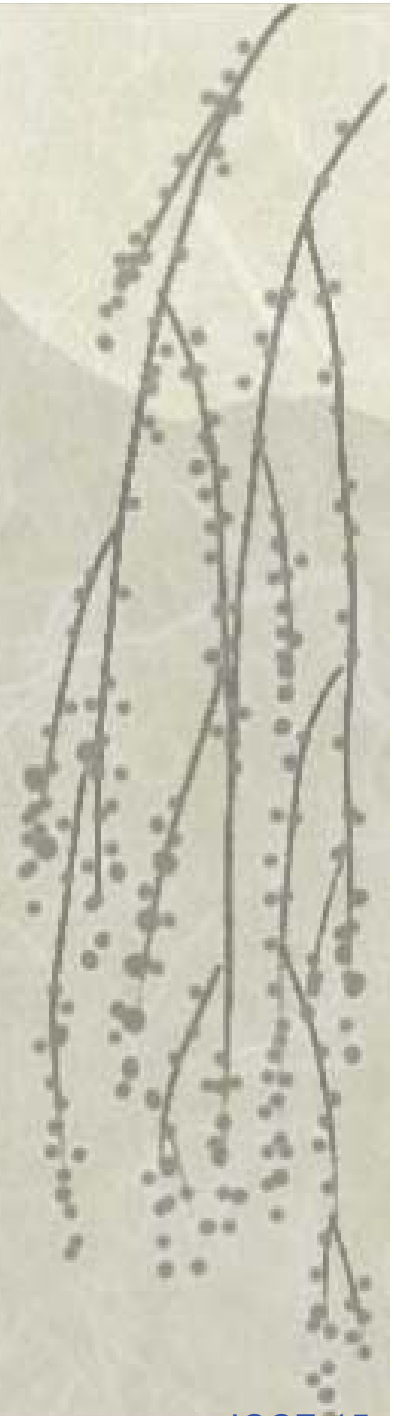




Modified Sample Stage to Accept Reaction Cell

Experimental Plan for Joint Research with MHI

- Bulk analysis of Pd
  - Key decision point
  - Sufficient Pr to explain MHI result?
  - NO! < 10 ppb/wt, i.e., < 7 ng total
- Sample production at MHI
- NRL observers at MHI
- Analysis at MHI and NRL

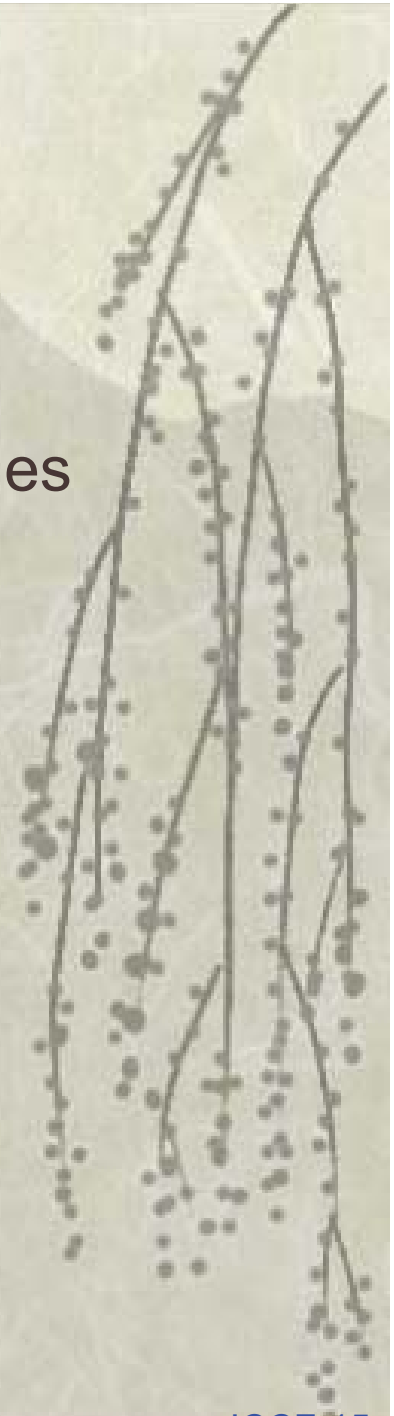


NRL Analysis (Pr in components)

Group		Cs solution	Pd foil	Comment
MHI components		1 of 1	4 of 2	Executed of Planned
			MHI 106 (< 0.6 ng/cm^2)	GDMS by NRL
			MHI 107 (<0.6 ng/cm^2)	GDMS by NRL
		< 8 pg per 20 mL	MHI 106 (42 pg/cm^2)	Bulk ICP-MS by NRL
			MHI 107 (53 pg/cm^2)	Bulk ICP-MS by NRL
			MHI 157 (<3 pg/cm^2)	Surface ICP-MS by NRL
			MHI 158 (<3 pg/cm^2)	Surface ICP-MS by NRL
Chisai	Cs Complex, Non-Permeated Blank	Non-Cs Complex, Permeated Blank	Cs Complex, Permeated	Comment
	0 of 3	0 of 3	3 of 3	Executed of Planned
			MHI 113 (<4 pg/cm^2)	Surface ICP-MS by NRL
			MHI 113 (36 pg/cm^2)	Bulk ICP-MS by NRL
			MHI 119 (10 pg/cm^2)	Surface ICP-MS by NRL
			MHI 119 (30 pg/cm^2)	Bulk ICP-MS by NRL
			MHI 124 (<3 pg/cm^2)	Surface ICP-MS by NRL
			MHI 124 (42 pg/cm^2)	Bulk ICP-MS by NRL

Observer's Tasks

- Monitor all production steps of selected samples
  - Starting materials and their cleaning
  - Annealing foils
  - Etching foils
  - Deposition of multilayer film
  - Deposition of Cs
  - Permeation processing
  - Storing and shipping

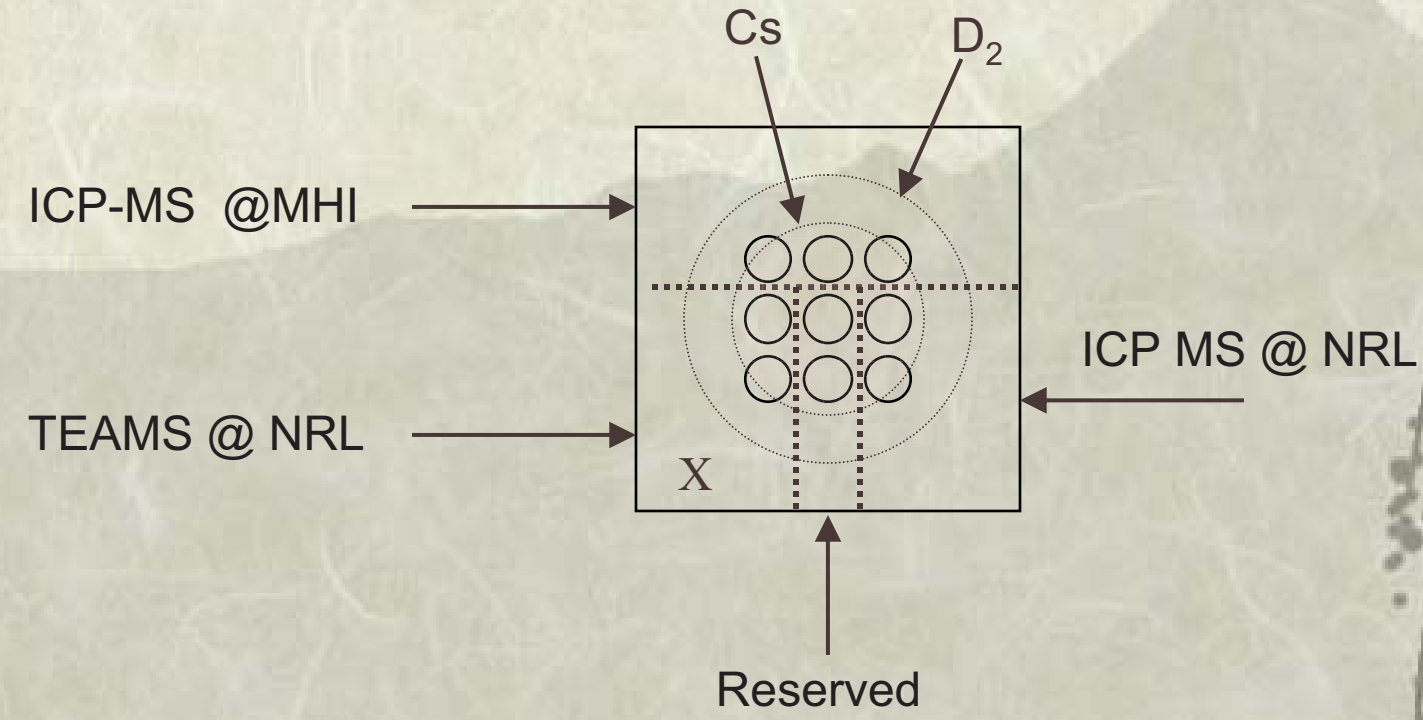


Observer's Tasks (2)

- Record observations without disrupting tasks
  - Video recording of key steps
  - Audio recording of instructions
  - Notations of events
- Review observations
  - Amongst NRL staff
  - With MHI staff, using translator for key discussions
- Report back to US
  - Frequently, digitally and verbally
  - In summary documentation

Foil - Analysis Layout

(typical)



Note: Lower 2/3 Sent to NRL for Analysis

Foil Specimens Planned

		Sample	Cs blank	Perm. blank
	Pd Foil, as Manufactured	**Cs Complex, Permeated**	**Cs Complex, Non-Permeated**	**Non-Cs Complex, Permeated**
XPS Chamber		3	3	3
Chisai Chamber		3	3	3
Total	2	6	6	6
Demonstrates:	Pr Not in Pd Foil	Pr Production	Initial Structure Free of Pr	No Bulk Redistribution Not From D_2

MHI samples & MHI analysis

Cs blank Perm. blank Sample

Group	Cs Complex, Non-Permeated Blank	Non-Cs Complex, Permeated Blank	Cs Complex, Permeated	Comment
XPS	3 of 3	3 of 3	3 of 3	Executed of Planned
	MHI 127 (0 ng/cm^2)	MHI 123 (0 ng/cm^2)	MHI 118 (13.4/20 ng/cm^2)	Surface ICP-MS by MHI
	MHI139 (0 ng/cm^2)	MHI 135 (0 ng/cm^2)	MHI 131 (7.8/9.2 ng/cm^2)	Surface ICP-MS by MHI
	MHI 151 (0 ng/cm^2)	MHI 147 (0 ng/cm^2)	MHI 143 (13/26 ng/cm^2)	Surface ICP-MS by MHI
Chisai	1 of 3	1 of 3	4 of 3	Executed of Planned
	MHI 101 (0 ng/cm^2)	MHI 109 (0 ng/cm^2)	MHI 103 (0 ng/cm^2)	Surface ICP-MS by MHI
			MHI 113 (0 ng/cm^2)	Surface ICP-MS by MHI
			MHI 119 (0 ng/cm^2)	Surface ICP-MS by MHI
			MHI 124 (0 ng/cm^2)	Surface ICP-MS by MHI
				Unknown Problem On Hold
Total	4 of 6	4 of 6	7 of 6	Executed of Planned

* Data listed from Takasago/Toray facilities