

Evaluation Session – Dec. 1, 2020

R.Q. Wright's Hf updates

- All stable Hf isotope (174, 176-180), RRR and URR + fast (n, g)
- Motivation? Deficiencies in the current ENDF/B-VIII.0?
 - Hf is popular neutron absorber and Zr replacement in cladding
 - No known (serious) deficiencies
- What new data/theory motivate a new evaluation/update?
 - New JENDL-4 evaluations
- What validation testing has been/will be done?
 - Hopefully a lot, but not by RQ

Hafnium Revisions 2020

Resolved Resonance Range:

| Isotope | NR | Range(eV) | Source |
|---------|-----|-----------|---------|
| Hf-174 | 11 | 0 - 220 | JENDL-4 |
| Hf-176 | 24 | 0 - 700 | JENDL-4 |
| Hf-177 | 180 | 0 - 250 | JENDL-4 |
| Hf-178 | 25 | 0 - 1500 | VIII.0 |
| Hf-179 | 105 | 0 - 250 | JENDL-4 |
| Hf-180 | 156 | 0 - 5000 | VIII.0 |

Unresolved Resonance Range:

| Isotope | Range(KeV) | Source |
|---------|------------|---------|
| Hf-174 | 0.22 - 100 | JENDL-4 |
| Hf-176 | 0.70 - 100 | JENDL-4 |
| Hf-177 | 0.25 - 50 | JENDL-4 |
| Hf-178 | 1.50 - 100 | JENDL-4 |
| Hf-179 | 0.25 - 50 | JENDL-4 |
| Hf-180 | 5.00 - 100 | JENDL-4 |

Minor changes to resonance data:

Unresolved scattering radius

Hf-174 bound level

Other minor changes

Minor changes to MF = 3 cross sections:

100 to 200 Kev, to join smoothly with unresolved

50 or 100 KeV to eliminate discontinuities

Thermal cross sections

| | Hf-174 | Hf-176 | Hf-177 | Hf-178 | Hf-179 | Hf-180 | Natural | ANR(2006) |
|---------|--------|--------|--------|--------|--------|--------|---------|-------------|
| Abun(%) | 0.16 | 5.26 | 18.60 | 27.28 | 13.62 | 35.08 | | |
| Total | 563.9 | 27.9 | 372.0 | 90.5 | 47.5 | 35.4 | 115.1 | 114.4 ± 0.4 |
| Elastic | 15.0 | 5.8 | 0.2 | 6.6 | 7.0 | 22.3 | 10.9 | 10.3 ± 0.4 |
| Capture | 548.8 | 22.1 | 371.8 | 83.9 | 40.5 | 13.1 | 104.2 | 104.1 ± 0.5 |
| RIC | 371 | 696 | 7203 | 1864 | 503 | 29.0 | 1964 | 1992 ± 50 |

Currently investigating fast region tweaks to smooth out URR-fast discontinuities

Revised capture above 100 KeV

- Revised capture shown as triangles:
 - For 0.1 to 1 MeV, use JENDL-4
 - For 1 to 2 MeV, use the measured data of Beer et al.
 - Above 2 MeV, mult. the JENDL-4 values by 1.1576 to match revised (n,g) at 2 MeV.
- Total cross section, calculate new sum of partials. Total will change by only a small amount. BNL would make fix.
- This evaluation would amount to the JENDL-4 (n,g) evaluation with relatively minor changes.

