

The text discusses materials and approaches for the Fusion Pilot Plant (FPP) divertor and first wall, highlighting the limitations of tungsten (W) and carbon-based materials, and advocating for the exploration of liquid metals, particularly lithium (Li). Key points include:

1. **Limitations of Tungsten and Carbon:**

- **Tungsten:** High Z core/edge radiation, neutron-induced brittleness, tritium (T) retention due to neutron-induced vacancies/voids, cracking/melting under high heat loads, and issues with cyclic thermal fatigue.
- **Carbon-Based Materials:** Tritium retention concerns and the need to re-evaluate assumptions leading to tritium inventory limits imposed by licensing agencies.

2. **Alternative Approaches:**

- **Renewable Wall Approach:** Needs further exploration as an alternative to tungsten and carbon.
- **Flowing Liquid Lithium:** Presents potential operational benefits, such as reducing recycling and increasing plasma performance. A design for a self-contained flowing lithium divertor module (ITEM) exists and could be tested on DIII-D.

3. **Liquid Metal Divertor (LMD):**

- **Advantages:** Can withstand high heat fluxes better than solid materials and solve many engineering issues associated with divertor sections.
- **Research Potential:** Offers an opportunity to study new materials and contribute to the advancement of fusion technology by demonstrating large areas of liquid metal exposed to plasma, operating within a tokamak environment, and investigating interactions with deuterium and helium in power-plant relevant configurations.

4. **Comparative Benefits:**

- **Differentiation:** Using liquid lithium would distinguish DIII-D from other tokamaks like ITER, EAST, KSTAR, ASDEX, WEST, DTT, and SPARC.
- **Bulk Tungsten:** Still of interest for studying mechanical properties under high heat flux and highly radiative/detached divertor plasma scenarios, but seen as a transitional material due to issues like transmutation, damage lifetime, dimensional change, and thermal transport.

5. **Conclusion:**

- **Primary Focus:** Liquid lithium is considered the only material compatible with tokamak plasma, providing low recycling and effective particle removal.
- **Experimental Goals:** DIII-D should develop an ambitious research plan focusing on liquid metals to differentiate from other medium-sized tokamaks and contribute significantly to the understanding and development of long-term fusion power solutions.