aluminum, for example, and adjacent can wall **44** can be reflector **32**. Cladding **16** can be over annulus **14** having liner **22** between annulus **14** and target material **12**. As can be seen in FIG. **4**, assembly **42** can include multiple discrete target materials **12**.

[0044] Referring next to FIGS. **5** and **5**A, another target assembly **52** is shown that includes at least one cross section shown in FIG. **5** and a transverse cross section shown in FIG. **5**A. In accordance with example implementations, can wall **44** can encompass reflector material **32** which can be associated with cladding **16** of annulus **14** having liner **22** between annulus **14** and target material **12**. In accordance with example implementations, target assembly **52** can include one or more caps **54**; and disposed adjacent caps **54** can be additional reflector material **32**.

[0045] The mass of the entire target assembly (as shown in FIGS. **1**, **2**, **3**, **4** and **5**) can be from about 10 grams to about 5000 grams. In accordance with example implementations, the mass can be from about 50 grams to 3000 grams. The diameter of the entire target assembly can be from about 1 centimeter to about 20 centimeters. In accordance with example implementations, the diameter can be from about 3 to 6 centimeters.

[0046] Referring to FIG. **6**, a transfer cask assembly **62** is shown for use with target assemblies such as target assembly **52** in the form of a can configuration. Referring to FIG. **7**, a reactor core pool can have a perimeter of core **72** and a discrete zone **74** configured to receive a can assembly such as target assembly **52**. Prior to reaction, target material **12** can include grams of 99.999% pure molybdenum metal powder, for example. According to example implementations, discrete zone **74** can be at a position such as D**8** (described later with reference to reactors as **126** in FIG. **12**). Assembly **52** can be removed and transferred to a transfer cask assembly **62** and eventually transferred to a reactor laydown area **76**.

[0047] Referring to FIGS. **8** and **8**A, target assembly **82** is shown according to another embodiment of the disclosure. Target assembly **82** is shown in one cross section in FIG. **8** and a transverse cross section in FIG. **8**A. In accordance with example implementations, target assembly **82** may also be considered a fuel element arrangement. Target assembly **82** can include a cladding **16** encompassing additional cladding over annulus **14** having liner **22** in between annulus **14** and target material **12**. In accordance with example implementations, target assembly **82** can include fixtures **88**. Fixtures **88** can be configured to be received by portions of a cluster assembly to allow for the transfer of assembly **82**. Fixture **88** can be used to grasp assembly **82** for movement into and out of the irradiation position within a reactor, for example. Assembly **82** may also include liner material **22** associated with target material **12**. Liner material **22** can be placed in between target material **12** and reflector material **84** as well, and reflector material **84** can be an upper and/or lower reflector. Reflector material **84** can be a mixture of graphite and beryllium, for example. Reflector material **84** may also function as a packing material in some implementations. Material **86** is an upper cap/fixture that can provide a method for attaching fixture **88** to the assembly **82**.

[0048] Referring to FIG. **9**, a cluster assembly **92** is shown that includes one or more elements **82** coupled to base **96** and handle **94**. Cross sections of cluster assembly **9** are shown in FIG. **9**A-**9**D. Referring to FIG. **9**A, a recess **97** is shown within base **96** that also includes sockets **98** that are configured to receive fixtures **88**, for example. Additionally, referring to FIG. **9**B, socket **98** is shown according to another cross section, and referring to FIG. **9**D, socket **99** is shown and configured to receive another fixture **88**, for example. In accordance with example implementations, base **96** may be configured as shown in FIG. **9**C.

[0049] Referring to FIG. **10**, an arrangement **102** is shown that shows a cross section of different base arrangements **96** having assemblies **82** therein. In accordance with another example embodiment and with reference to FIG. **10**A, arrangement **104** can include clusters having a handle **104** with a cutout **108** to provide clearance for the removal of an annulus without requiring removal of the entire fuel assembly to retrieve the target.

[0050] In accordance with example implementations and with reference to FIG. **11**, at least one example of a flow diagram for reacting target material as configured in the present disclosure is provided. In accordance with one example, a molybdenum target can be inserted into a position with an annular uranium element. The target can be irradiated. The irradiated molybdenum can be retrieved and cooled. Cooling can allow for short half life trace materials such as ^{41}Ar to decay away providing a ^{99}Mo radioisotope.

[0051] Referring to FIG. **12**, an example reactor **122** is shown. Reactor **122** can have one or more discrete zones configured to receive target material; a core position **124**, for example, as well as a perimeter position **126**, sometimes referred to as the D**8** position, can be considered to be one or more of these zones.

[0052] The target material can consist essentially of non-uranium material as described herein. Reactor **122** can also include at least one uranium-comprising annulus individually with the one or more discrete zones, the annulus being as described herein with the volume of the annulus configured to receive an entirety of the target material in at least one cross section. In accordance with example implementations, the annulus can be coupled to the reactor and/or may also be removable from the reactor. Neutrons can be provided by the reactor to the target material as a neutron flux which is increased within the annulus as a result of the concentrating effects of the annulus, for example. Discrete zones may also include one or more reflector components arranged along the perimeter of the target material and/or annulus. Methods also include reflecting of the neutrons by, e.g., the reflector components, to create a flux trap within the annulus. The discrete zone may also include one or more liners associated with the inner diameter of the annulus. The methods can also include filtering the neutrons as they are provided to the target material. In accordance with example implementations, liners **22** comprised of materials such as cadmium or boron compounds can be selected that absorb the thermal neutrons produced in the reactor core, allowing the epithermal and fast neutrons to selectively pass to the target material. For purposes of illustration only, the thermal neutron spectrum can include energy levels less than 1 electron-volt (eV). The epithermal or resonance neutron spectrum can include energy levels greater than 1 eV but less than about 0.5 MeV, while the fast neutron spectrum can include energy levels greater than about 0.5 MeV. In accordance with additional embodiments, the production of the high energy neutrons using the target assembly may be used to treat or to modify materials such as gemstones. Gemologists treat gems such as topaz with epithermal and fast neutrons, for example.

[0053] The target material as described above can consist essentially of non-uranium-comprising material, such as P, S,