Claims

1. An apparatus for recycling a battery, the apparatus comprising:

a sealed chamber having a loading port formed on an upper portion and an unloading port formed on a lower portion;

a vacuum device coupled to the sealed chamber for withdrawing air from the sealed chamber;

a first gas supply device coupled to the sealed chamber for providing a flame retardant gas into the sealed chamber;

a conveyor belt disposed in the sealed chamber, the conveyor belt having a first section positioned under the loading port, a second section positioned above the unloading port, with respect to a vertical direction of the sealed chamber, and a third section between the first section and the second section,

a second gas supply device coupled to the sealed chamber for providing a coolant into the sealed chamber;

a cutting device coupled to the sealed chamber for performing a severing operation in the sealed chamber,

wherein the conveyor belt is operable to receive a battery received from the loading port and transport the battery to the third section;

wherein the cutting device is operable to sever a battery brought to the third section by the conveyor belt into fragments,

wherein the conveyor belt is operable to transport the fragments to the second section and to bring the fragments to the unloading port, and

wherein the cutting device is a laser cutter configured to direct a laser beam onto the third section of the conveyor belt for severing the battery into the fragments.

2. The apparatus as recited in claim 1, wherein the loading port comprises an outer entrance port, an inner entrance port and a transition entrance chamber between the outer entrance port and the inner entrance port; and wherein the inner entrance port is closed while the outer entrance port is opened to receive the battery into the transition entrance chamber, and the outer entrance port is closed while the inner

entrance port opened to allow the battery to drop from the transition entrance chamber onto the first section of the conveyor belt.

3. The apparatus as recited in claim 1 or 2, wherein the unloading port comprises an inner exit port, an outer exit port and a transition exit chamber between the inner exit port and the outer exit port, and wherein the outer exit port is closed while the inner exit port is opened to receive the fragments into the transition exit chamber, and the inner exit port is closed while the outer exit port is opened to allow the fragments to drop from the transition exit chamber out of the sealed chamber through the outer exit port.

4. The apparatus as recited in claim 1, wherein the first gas supply device is configured to provide a nitrogen gas or an inert gas into the sealed chamber.

5. The apparatus as recited in claim 1, wherein the second gas supply device is configured to provide a cooled nitrogen gas generated by a liquid nitrogen.

6. The apparatus as recited in claim 5, wherein the second gas supply device is configured to provide a cooled nitrogen gas directly onto the battery at the third section of the conveyor belt to cool the battery before and during cutting.

7. The apparatus as recited in claim 1, wherein the vacuum device is configured to maintain an air pressure in the sealed chamber to be lower than the atmosphere.

8. A method for recycling a battery, the method comprising:
placing a battery into a sealed chamber through a loading port of the sealed chamber;
receiving the battery onto a conveyor belt disposed in the sealed chamber;
transporting the battery to a third section of the conveyor belt;
reducing an air pressure of the sealed chamber;
introducing a flame regardant gas into the sealed chamber;
reducing a temperature of the sealed chamber;

severing the battery into fragments in the sealed chamber;

transporting the fragments by the conveyor belt to a second section of the conveyor belt and bringing the fragments to an unloading port of the sealed chamber,

collecting the fragments at the unloading port;

wherein severing the battery comprises directing a laser beam to move across and through the battery.

9. The method as recited in claim 8, wherein placing the battery into the sealed chamber comprises:

closing an inner entrance port of the sealed chamber;

loading the battery into a transition entrance chamber;

closing an outer entrance port of the sealed chamber, and

opening the inner entrance port of the sealed chamber to allow the battery to drop into the sealed chamber.

10. The method as recited in claim 8, wherein reducing an air pressure of the sealed chamber comprises activating a vacuum pump connected to the sealed chamber to withdraw air from the sealed chamber.

11. The method as recited in claim 8, wherein introducing a flame regardant gas into the sealed chamber comprises introducing a nitrogen gas or an inert gas into the sealed chamber.

12. The method as recited in claim 8, wherein reducing a temperature of the sealed chamber comprises introducing a coolant into the sealed chamber.

13. The method as recited in claim 12 wherein the coolant comprises a cooled nitrogen gas generated by a liquid nitrogen.

14. The method as recited in claim 12 wherein reducing a temperature of the sealed chamber comprises introducing the coolant directly onto the battery.

15. The method as recited in claim 8, wherein collecting the fragments comprises:

closing an outer exit port of the sealed chamber;

receiving the fragments into a transition exit chamber;

closing an inner exit port of the sealed chamber, and

opening the outer exit port of the sealed chamber to allow the fragments to be collected outside of the chamber.