

## 5. Safety of small li-ion rechargeable batteries

### 5-1 Safety settings of small li-ion rechargeable batteries

Lithium titanate is used as the active material in the anodes of small li-ion rechargeable batteries. Selection of a highly safe active material as the anode results in excellent safety. For this reason, the SLB exhibits a high

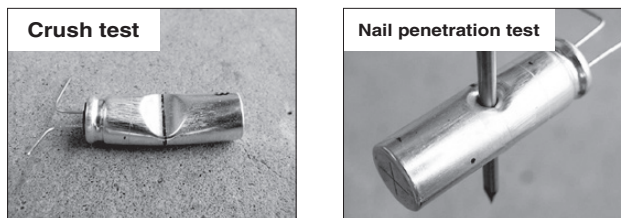
degree of safety and has passed a variety of safety tests, including external short-circuit, overcharge, forced discharge, and nail penetration tests.

### 5-2 Safety testing of small li-ion rechargeable batteries

Table 5-1 indicates the safety tests small li-ion rechargeable batteries have passed.

**Table 5-1. Safety test categories for small li-ion rechargeable batteries**

No.	Test parameter	Reference standard	Test details	Judgment criteria	Proof of safety
1	Crushing	JIS C 8712	After charging fully, a semicircular indenter (10mm) is used to indent a cylindrical battery's vertical axis, crushing it to 50% of its height before the test.	Does not explode or burst into flame	No explosion or flames
2	Nail penetration	Safety assessment standards and guidelines of the Battery Association of Japan	After fully charging, a nail of $\phi 3.0\text{mm}$ is inserted vertically into the center of the battery at a speed of 5.5mm/s, piercing through the battery.	Does not explode or burst into flame	No explosion or flames
3	Blunt nail test	UL	Pressure is applied to a blunt nail approaching fully charged battery at a speed of 0.1mm/s. A short circuit is deemed to occur if battery voltage drops by 0.5V or more, and the lowering of the nail is halted.	Does not explode or burst into flame	No explosion or flames
4	Exterior short circuit	JIS C 8712	A battery's cathode and anode are connected to an external resistance of approximately $1\text{m}\Omega$ , causing a short circuit.	Does not explode or burst into flame	No explosion or flames
5	Overcharge	JIS C 8712	Using a battery that can be used at 10V or more, charge from a discharged state at 1C (or 2-10C) to 250% of the battery's rated capacity.	Does not explode or burst into flame	No explosion or flames
6	Forced discharge	JIS C 8712	Conduct a reverse charge of a battery from its discharged state (SOC of 0%) for 90 minutes at 1C.	Does not explode or burst into flame	No explosion or flames



**Figure 5-1. Safety test examples**  
(left: crush test; right: nail penetration test)

Table 5-2 indicates the safety tests with the recommended United Nations tests for goods to be

transported (UN38.3). The SLB has passed all of these tests, indicating it can be shipped overseas.

**Table 5-2. Details of implemented UN standards and results**

	Test parameter	Requirements	Result
T1	High-speed simulation	No leaks, valve operation, rupturing, cleavage or fires and, except for batteries that are fully discharged, the open circuit voltage is 90% or more than the level just before the test.	Pass
T2	Temperature test	No leaks, valve operation, rupturing, cleavage or fires and, except for batteries that are fully discharged, the open circuit voltage is 90% or more than the level just before the test.	Pass
T3	Vibration	No leaks, valve operation, rupturing, cleavage or fires during or after the test and, except for batteries that are fully discharged, the average voltage is 90% or more than the level just before the test.	Pass
T4	Impact	No leaks, valve operation, rupturing, cleavage or fires and, except for batteries that are fully discharged, the open circuit voltage is 90% or more than the level just before the test.	Pass
T5	External shortening	External temperature does not exceed 170°C, and no rupture, cleavage or fire occurs during testing or within six (6) hours afterward.	Pass
T6	Crushing	External temperature does not exceed 170°C, and no rupture, cleavage or fire occurs during testing or within six (6) hours afterward.	Pass
T7	Overcharge	Does not apply, as for secondary batteries only	—
T8	Forced discharge	No bursting or fires occur during testing or within seven days afterward.	Pass