16th EVS GTR

EV Li-ion Battery Caused Toxics and Analysis

September 2018

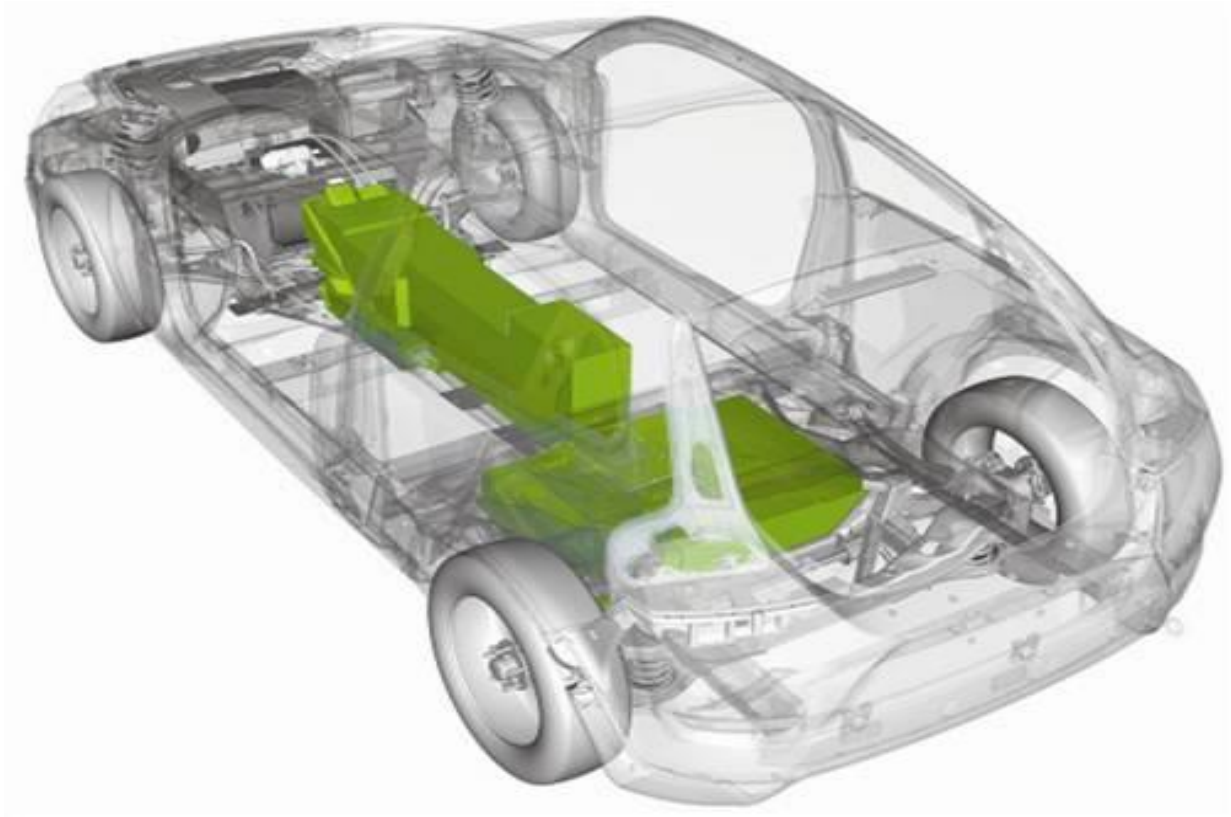
Contents

1 Li-ion Battery toxics threat always exists

An improved understanding and control of the Li-ion battery safety, development and induced thermal and chemical threat is actually needed.

With CO_x, HF, PO_x and toxic VOCs and Dense smoke

1 Li-ion Battery toxics threat always exists



With electrolyte Volatilization and toxic VOCs in the car carriage

2.1.1 classification of toxics

Level	GB5044			GBZ230					WHO/IPCS		
	inhalation	via skin	via mouth	Inhalation			via skin	via mouth	via mouth	via skin	Inhalation
	LC50	LD50	LD50	Gas	Vapor	Mog					
	mg/m^3	mg/kg	mg/kg	cm^3/m^3	mg/m^3	mg/m^3	mg/kg	mg/kg	mg/kg	mg/kg	mg/m^3,4h
I/Very Toxic	< 200	< 100	< 25	< 100	< 500	< 50	< 5	< 50	< 25	< 50	< 500
II/Highly Toxic	200 ~ 2000	100 ~ 500	25 ~ 500	100 ~ 500	500 ~ 2000	50 ~ 500	5 ~ 50	50 ~ 200			
III/Toxic	2000 ~ 20000	500 ~ 2500	500 ~ 5000	500 ~ 2500	2000 ~ 10000	500 ~ 1000	50 ~ 300	200 ~ 1000	25 ~ 200	50 ~ 400	500 ~ 2000
IV/Harmful									200 ~ 2 000	400 ~ 2000	2000 ~ 20000
V/Low Toxic	> 20000	> 2500	> 5000	2500 ~ 20000	10000 ~ 20000	1000 ~ 5000	300 ~ 2000	1000 ~ 2000			
VI/Few Toxic				> 20000	> 20000	> 5000	> 2000	> 2000			

Six levels classification including I (very toxic), II (highly toxic), III (toxic), IV (harmful) and V (low toxic) and VI (Few Toxic) level was defined.

According to:

GB5044-1985: Classification of health hazard levels from occupational exposure to toxic substances,

GBZ230-2010: Classification for hazards of occupational exposure to toxicant ,

WHO/IPCS: The User's Manual for the IPCS Health and Safety Guides.

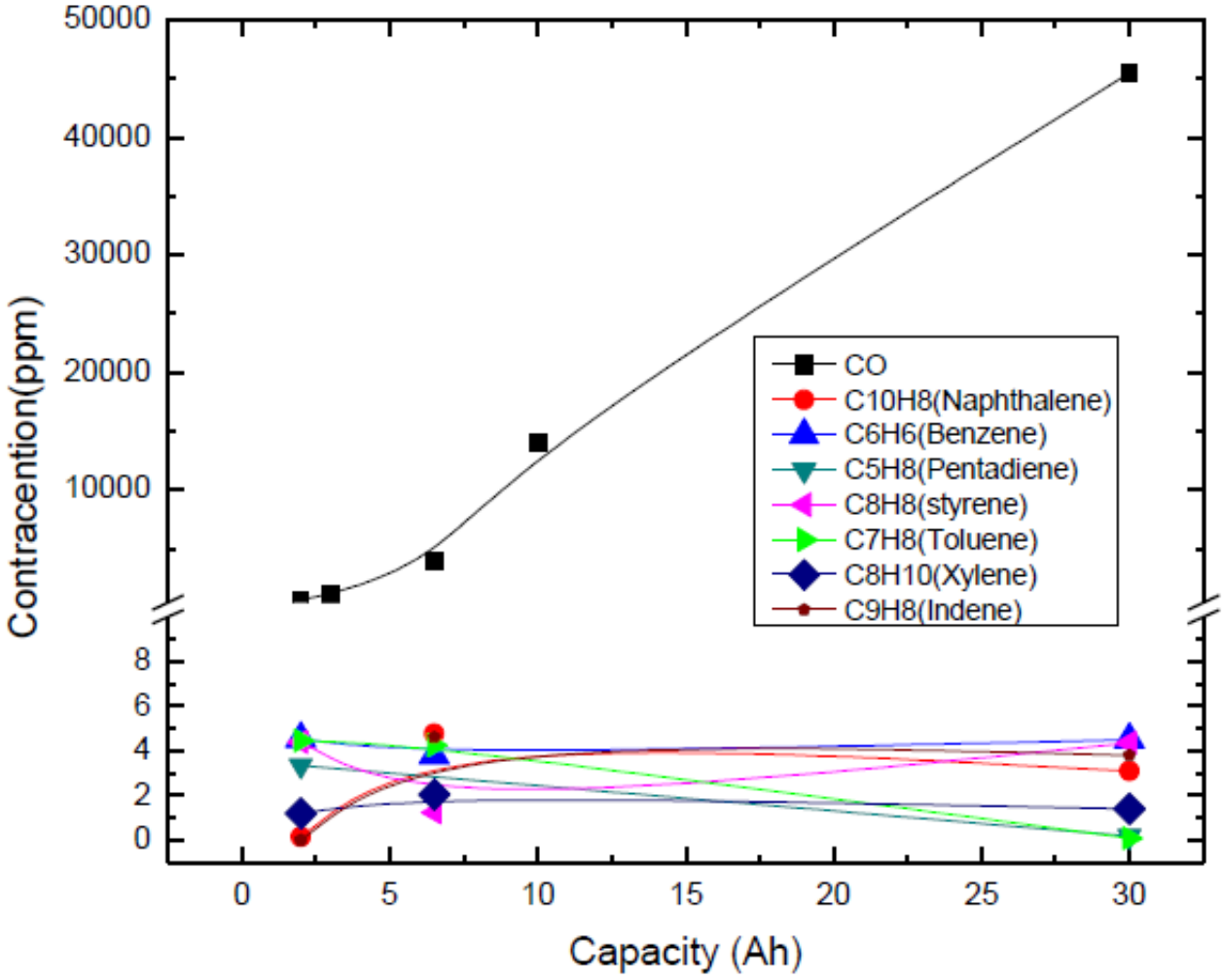
J Sun, JG Li, T Zhou, K Yang, H Li, X P Qiu, L Q Chen , **Nano Energy , 2016. 7**

2.1.2 Database of Li-ion Battery Thermal Runaway Organic toxics

No.	Compound	CAS	Toxity grading	LCB	LMB	NMC	LPB
1	2-Propenal (C_3H_4O)	107-02-8	rank poison	0%, 150%	50%	0%,50%	50%
2	Propanedinitrile ($C_3H_2N_2$)	109-77-3	rank poison			100%	
3	Propanenitrile (C_3H_5N)	107-12-0	rank poison			100%	
4	Naphthalene ($C_{10}H_8$)	91-20-3	high toxic	50%,100%,150%		0%,100%,150%	
5	Carbonyl sulfide (COS)	463-58-1	high toxic		0%		
6	Butane, 1-isocyanato- (C_5H_9NO)	111-36-4	high toxic		50%, 100%	100%	
7	Oxirane, ethyl- (C_4H_8O)	106-88-7	high toxic	50%, 100%	50%,100%		
8	1,3-Pentadiene （C_5H_8）	504-60-9	high toxic	50%, 100%			
9	1-Butanamine ($C_4H_{11}N$)	109-73-9	high toxic				0%
10	1,3-Cyclopentadiene (C_5H_6)	542-92-7	high toxic	100%, 50%	100%	100%,150%	
11	2-methyl-2-Propanamine ($C_4H_{11}N$)	75-64-9	high toxic	0%, 150%	100%		100%
12	Propyleneoxide （C_3H_6O）	75-56-9	high toxic	0%, 150%			
13	Sulfur dioxide (SO_2)	7446/9/5	high toxic				150%
14	2-Butene （C_4H_8）	107-01-7	medium toxic	50%, 100%		50%, 150%	100%
15	1,4-Dioxane ($C_4H_8O_2$)	123-91-1	medium toxic				150%
16	Benzene(C_6H_6)	71-43-2	medium toxic	0%,50%,100%, 150%	0%,50%,100%, 150%	0%,50%,100%, 150%	50%,100%

J Sun, JG Li, T Zhou, K Yang, H Li, X P Qiu, L Q Chen , ***Nano Energy*** , **2016. 7**

2.1.3 The toxics concerntrations changing tendency of 100% SOC NMC LIBs combustion

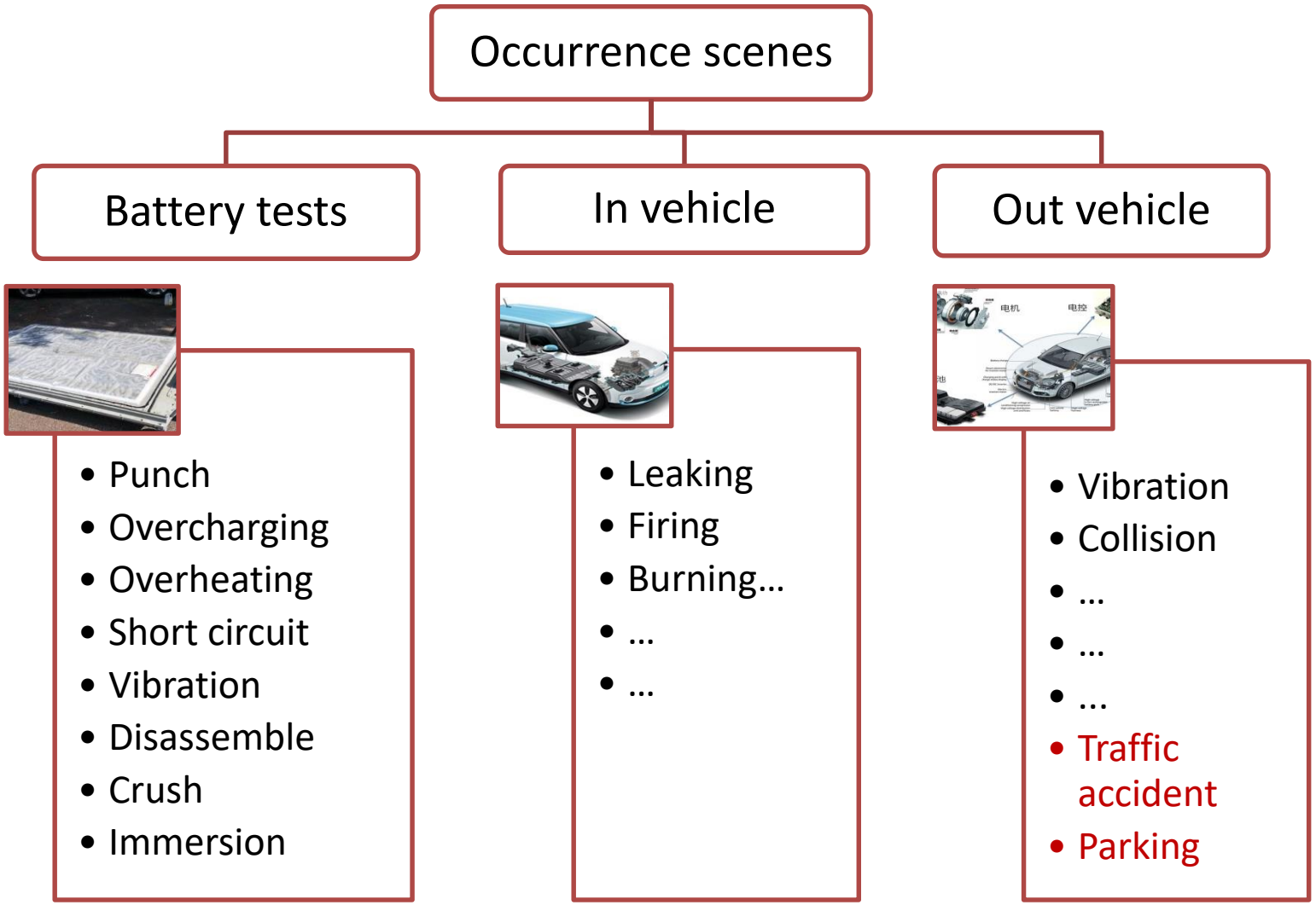


J Sun, JG Li, T Zhou, K Yang, H Li, X P Qiu, L Q Chen , ***Nano Energy*** , **2016. 7**

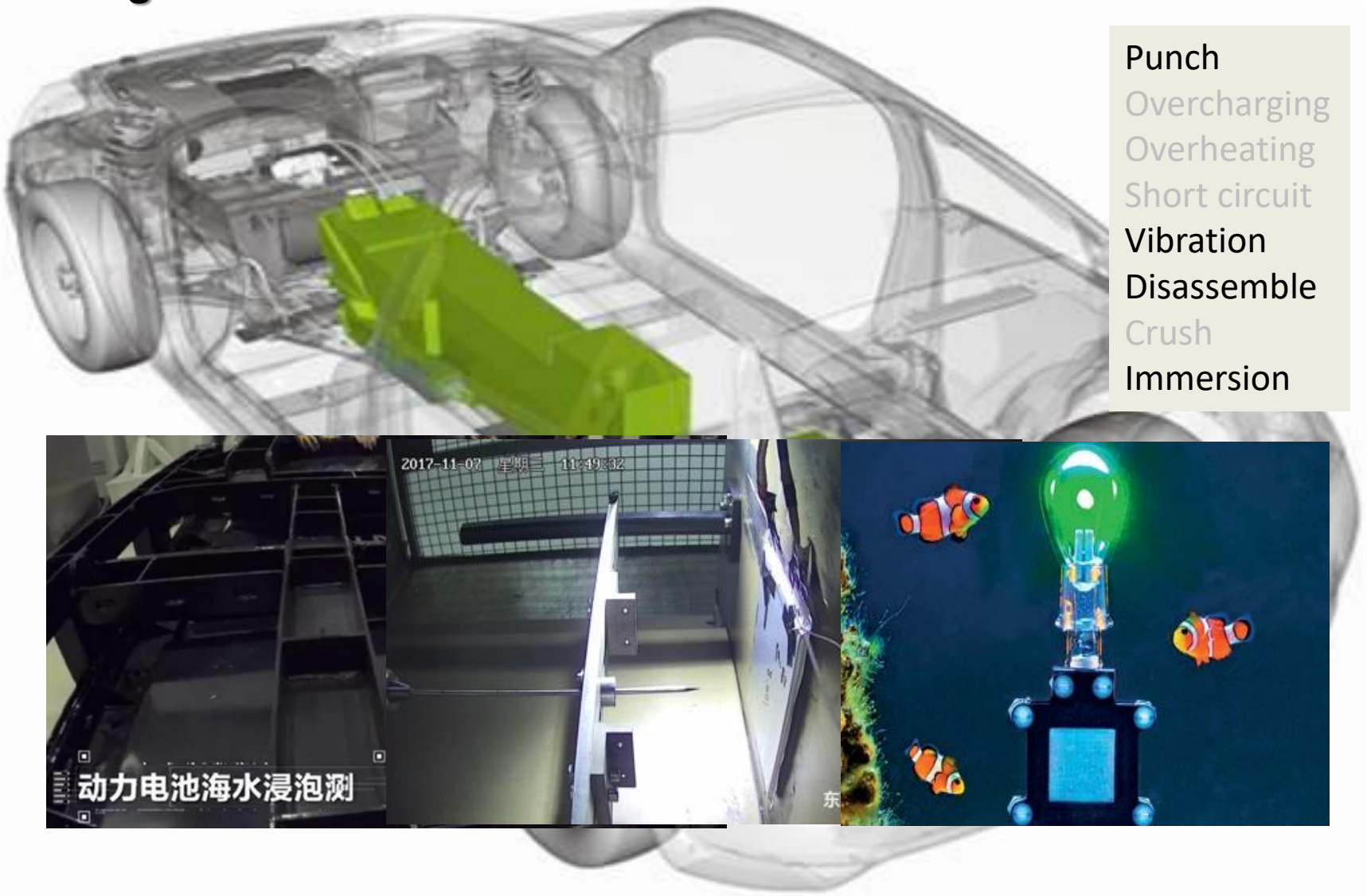
2.2 To test and monitor the EV toxic gases is very necessary

- Add examinations items of the toxic VOC in EV carriage.
- Add examinations of the toxic gases leaked from EV battery caused by Li-ion battery thermal runaway.
- Need new designation or criterion to test the toxic gases leaked form the EV battery in normal state and un-normal state.
- Need relative alarm and protective apparatus for EV.
- We need pay more attention and support to this area !

2.3.1 Occurrence scenes of Li-ion battery Thermal Runaway toxic leakage



2.3.2 Occurrence scenes of Li-ion battery Thermal Runaway toxic leakage



Punch
Overcharging
Overheating
Short circuit
Vibration
Disassemble
Crush
Immersion

2.3.3 Occurrence scenes of Li-ion battery Thermal Runaway toxic leakage

Burning

Leaking

Firing

Drop test

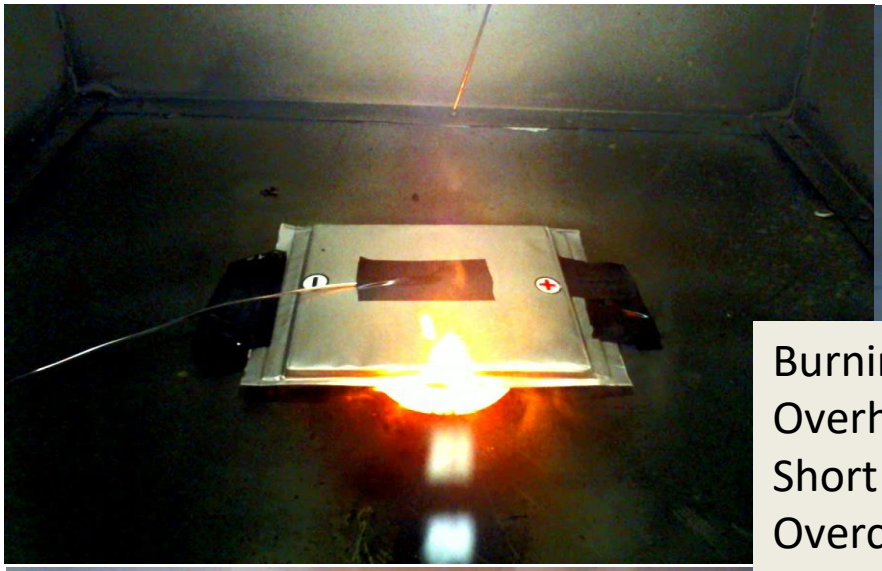
Vibration

Collision

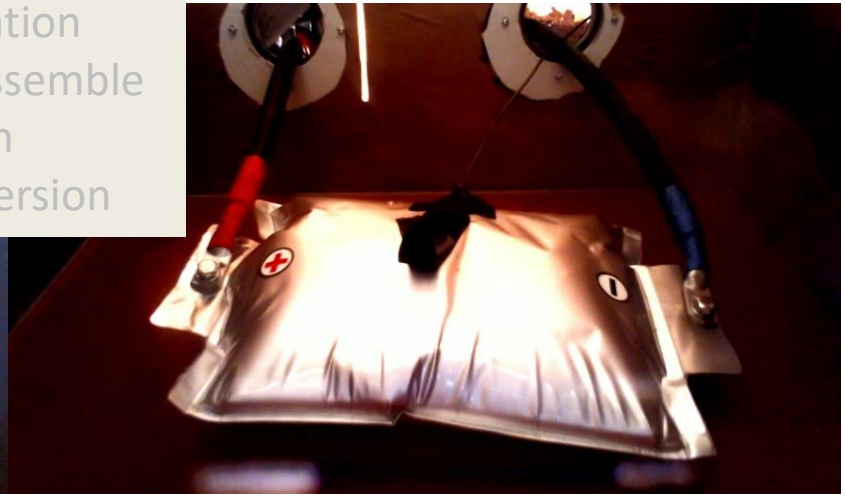
Traffic accident

Parking

2.3.4 Occurrence scenes of Li-ion battery Thermal Runaway toxic leakage



Burning
Overheating
Short circuit
Overcharging
Vibration
Disassemble
Crush
Immersion



2.3.5 Occurrence scenes of Li-ion battery Thermal Runaway toxic leakage

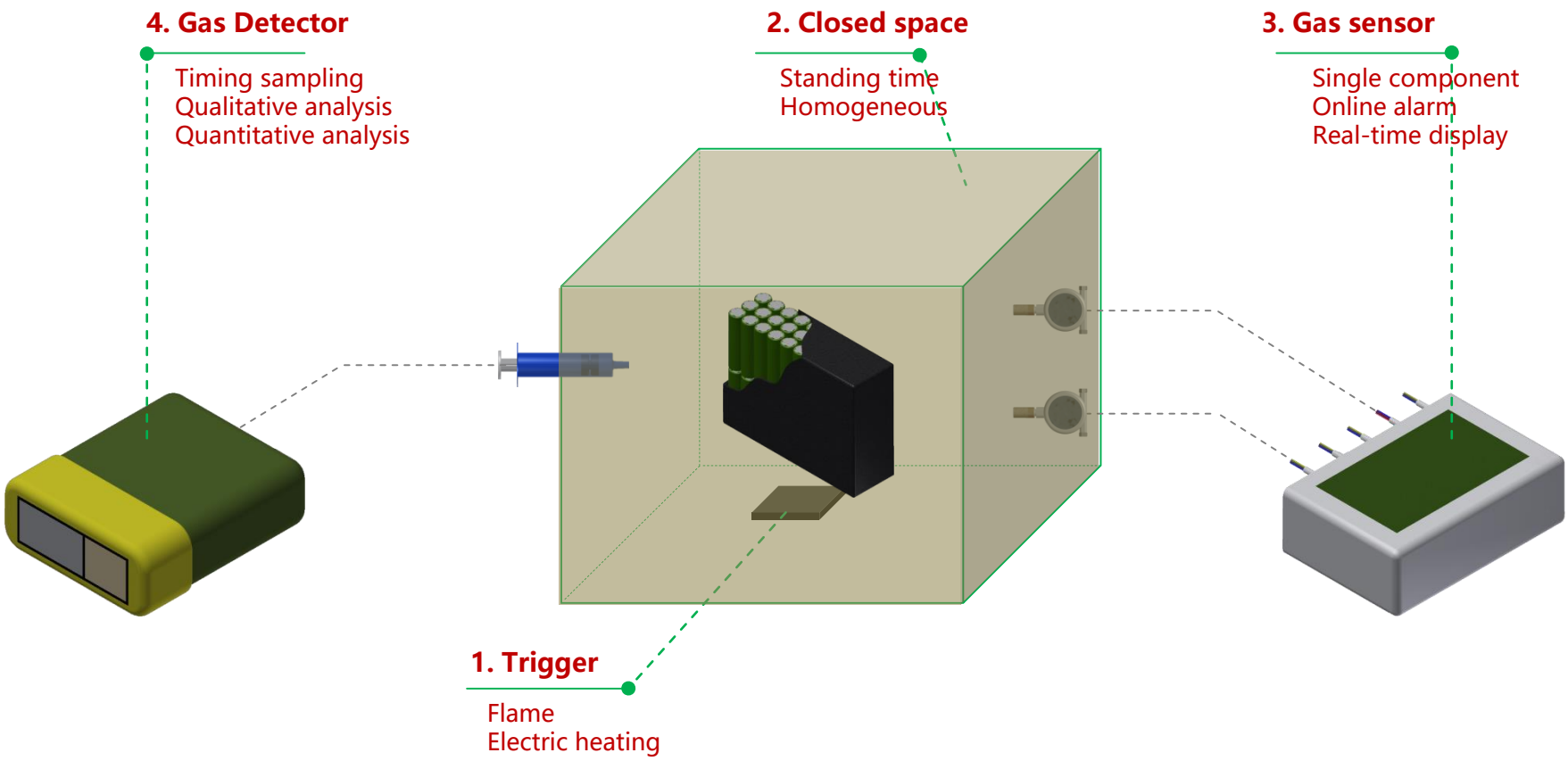
Burning
Overheating
Short circuit
Overcharging
Vibration
Disassemble
Crush
Immersion

Electrolyte Volatilization in the car carriage?

It is easy to design the experimental:
two normal working conditions, parking and driving,
to test the components of air in the car in different time quantum.

2.4 Standard methods to test Li-ion Battery Thermal Runaway toxic gases

Pack Test



2.5 We advice to add EV Li-ion Battery toxics inspection

- **Add examinations items of the toxic VOC in EV carriage**
- **Add cell toxics test to all the scenes of the possibility of thermal runaway**
- **Add pack toxics test to all the scenes of the possibility of thermal runaway**
- **The toxic gases need to limit type (Flammability, toxicity, corrosiveness) and concentration**
- **The limited concentration should according to** GBZ230-2010,WHO/IPCS, and the **real test value**.
- **Database and classification of Li-ion Battery Thermal Runaway toxics need to supplement and unify.**

Thanks for your attention!