A Novel Method for Oblate Spherical Powder with Adjustable Combustion Property

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Abstract

In order to obtain the oblate spherical power with adjustable combustion property, a novel method was put forward combining the microporous technology and the polymer deterring technology. In this work, the oblate spherical power was foamed with the cell structure by supercritical carbon dioxide (SC-CO_2), and then poly(neopentanediol adipate) (NA) was employed as the deterrent to modify the energy releasing rates in the surface. The combustion property of oblate spherical power under different processing conditions was investigated by the closed bomb tests. The results indicated that the microporous oblate spherical powder displayed the desired progressive combustion, and the combustion property of microporous oblate spherical powder could be adjusted by controlling the desorption time, foaming temperature, NA content, desensitization time and desensitization temperature. The spherical powder with skin-core structure foamed by SC-CO_2 and deterred by NA provides a novel and promising method to realize the progressive combustion performance without dibutyl phthalate (DBP).

Materials and Method

- Foaming process

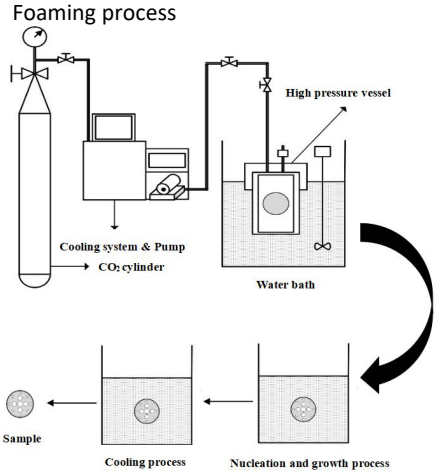

Figure.1 Flow chart of foaming process.

Table.1 Process conditions of microporous oblate spherical propellants.

Sample	1#	2#	3#	4#	5#
saturation time t_s/min	2	4	8	4	4
foaming temperature T_f/°C	84	84	84	76	90

- Surface modification process

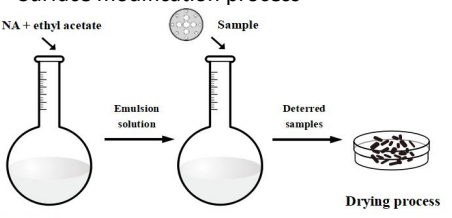

Figure.2 Flow chart of surface modification process.

Table.2 Process conditions of surface modification.

Sample	6#	7#	8#	9#	10#	11#	12#
NA content/wt%	1.5	3.5	4.5	3.5	3.5	3.5	3.5
desensitization time td/min	60	60	60	30	120	60	60
desensitization temperature Td/°C	85	85	85	85	85	75	80

Results

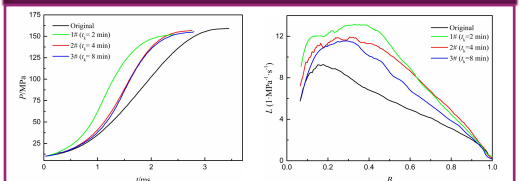

Figure.2 The P-t curve and the L-B curve of oblate spherical powder for different desorption time.

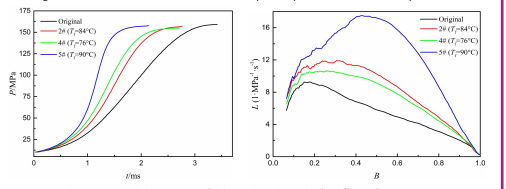

Figure.3 The P-t curve and the L-B curve of oblate spherical powder for different foaming temperature.

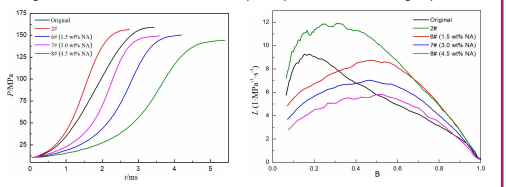

Figure.4 The P-t curve and the L-B curve of oblate spherical powder for different added content of NA.

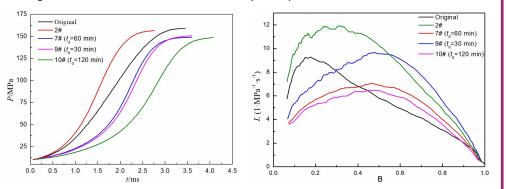

Figure.5 The P-t curve and the L-B curve of oblate spherical powder for different desensitization time.

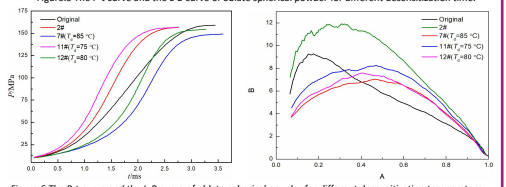

Figure.6 The P-t curve and the L-B curve of oblate spherical powder for different desensitization temperature.

Table.3 The values of burning time to maximum pressure and maximum pressure for different samples.

Sample label	Burning time to maximum pressure t_m/ms	Maximum pressure P_m/MPa
Original	3.45	159.10
1#	2.47	153.35
2#	2.76	156.75
3#	2.79	155.34
4#	2.72	155.04
5#	2.14	157.78
6#	4.19	150.25
7#	3.59	149.21
8#	5.41	144.36
9#	3.58	150.78
10#	4.07	148.87
11#	2.75	156.95
12#	3.27	154.62

Conclusions

- The original propellant had longer burning time to maximum pressure and larger maximum pressure, but the initial dynamic vivacity and the overall dynamic vivacity of microporous oblate spherical powder were both higher than the original propellant.
- The microporous oblate spherical powder displayed the desired progressive combustion, and the combustion property of microporous oblate spherical powder could be adjusted by controlling the desorption time and foaming temperature.
- The NA deterred samples had longer burning time, lower maximum pressure and samller dynamic vivacity, which can modify the energy releasing rates in the surface by changing NA content, desensitization time and desensitization temperature.
- Generally speaking, the thickness of surface modification layer played the most important role in the adjustment of combustion property. The idea of this paper provides a novel and promising method to realize the progressive combustion performance without dibutyl phthalate.

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