

INVESTIGATION OF THERMAL PROPERTIES OF ACTIVATED ALUMINUM POWDERS

E. N. Shakhmaeva, I. V. Chemagina, A. V. Sarafannikov

FSUE «RFNC – VNIITF named after Academ. E. I. Zababakhin», Snezhinsk, Russia

Aluminum powders are used in explosive compounds to enhance their performance. Despite the high level of energy capacity, one fails to fully implement their potential. This is due to both relatively large size of particles used and the presence of an oxide film with high protective properties on their surface [1].

In recent years much attention has been paid to the development of various aluminum activation methods to maximize the potential of powdered aluminum. The paper presents the results of thermal analysis of aluminum powders activated by various methods. The investigation included thermal analysis using thermogravimetric and differential thermal analyzers. Table 1 gives the names and characteristics of the tested samples of activated aluminum powders [2, 3].

Table 1

Samples of activated aluminum powders

Sample	Aluminum composition and fabrication method	Average particle diameter, μm
Nanoaluminum	High-energy milling method	0.07–0.80
Aluminum g/ph (gas-phase)	Gas-phase synthesis with subsequent passivation	0.04–0.30
“Start 1”	ASD-4 + 2%V ₂ O ₅ Surface coating	8.9±1.8
“Start 2”	ASD-4 + 2%Fe(NO ₃) ₃ Surface coating	8.3±1.6
“Start 3”	ASD-4 + 5%Fe(NO ₃) ₃ Surface coating	11.8±1.8
“Start 4”	ASD-4 + 2%V ₂ O ₅ + 5%Fe(NO ₃) ₃ Surface coating	9.7±1.9
“Start 5”	PA-4 + 2%V ₂ O ₅ Surface coating	32.7±6.5
“Start 6”	PA-4 + 2%Fe(NO ₃) ₃ Surface coating	33.8±6.8

When heated in air, aluminum powders oxidize with heat release. The increase in sample mass was recorded on thermogravimetric analysis (TGA) curves in two stages: the first stage is below the melting point of aluminum, and the second one is above this point.

The thermal analysis data showed that oxidation parameters of the activated powders differed from those of the original ones; aluminum activation resulted in the increased aluminum reactivity, the oxidation temperature of aluminum decreased significantly, and the maximum weight gain increased. The highest reactivity was observed for the g/ph aluminum sample.

References

1. **Eselevich, D. A.** Analysis of activity and completeness of oxidation of dispersed aluminum, modified by surface-active agents of different nature (Ca, Ba, V₂O₅) [Text] : Ph.D. thesis in Chemistry. – Ekaterinburg : Institute of Solid State Chemistry of the Ural Branch of the Russian Academy of Sciences, 2015. (In Russian).
2. **Ermakov, A. E.** Development, synthesis and analysis of aluminum disperse powders in nanometer range [Text] : scientific technical report. – Ekaterinburg : Mikheev Institute of Metal Physics of the Ural Branch of the Russian Academy of Sciences, 2004. (In Russian).
3. Activated aluminum powders. Tentative specifications. TS 179111.179112-001-04683390-16.08.23. Federal Government Budgetary Scientific Institution “Institute of Solid State Chemistry” of the Ural Branch of the Russian Academy of Sciences (ISSC of UB RAS), 2023. (In Russian).