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Design of Ti- and Ta-based materials by SHS

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Self-propagating high-temperature synthesis (SHS), or synthesis by combustion, is based on exothermic reactions between the elements and/or compounds. This technique is advantageous over existing processes by (i) no need for external energy supply, (ii) high reaction rates, and (iii) simplicity of facilities. SHS can be carried out in the mode of either layer-by-layer combustion or thermal explosion (volume reaction). The applicability of SHS method to fabrication of materials with desired properties was demonstrated in [1-4]. In this communication, I will report on some recent results on the combustion synthesis of Ti- and Ta-based materials. Due to unique combination of their properties, such materials are widely used in industry as structural and functional materials. This work aimed at exploring the feasibility of preparation of Ti–Al–Ta alloys from the elements in a mode of thermal explosion. In experiments, we studied the influence of the size/morphology of powders and mechanical activation of the powders on reaction mechanism and product patterning. Another goal was the deposition of multilayer ceramic Ti–C–Si coatings onto Ti and Ta substrates. Ti-Al-Ta-based alloys can be synthesized by thermal explosion without introduction of non-metal additives into the green mixture. SHS method can be readily applied to deposition of multilayer ceramic coatings onto a Ti and Ta substrate, without use of low-melting metal (intermediate layers). The use of SHS reactions for the purpose was found rather promising.

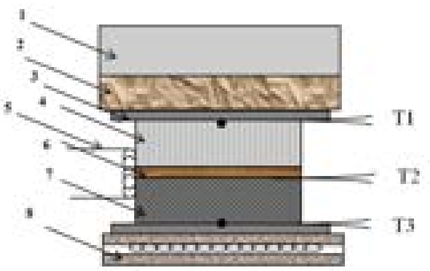

Figure 1: 1 – load (3360 g); 2 – (SiO_2–Al_2O_3) plate; 3 – Ta foils; 4 – 5Ti–3Si pellet; 5 – igniting coil and igniting (Ti–2B) film; 6 – Ti–0.65C pellet; 7 – Ta foils; 8 – electrically heated base; T1, T2, T3 thermocouples.

Recent Publications

1. E A Levashov, A S Mukasyan, A S Rogachev and D V Shtansky (2017) Self-propagating high-temperature synthesis of advanced materials and coatings, International Materials Reviews, 62(4):203–239.
2. A Varma, A S Mukasyan, A S Rogachev, K V Manukyan (2016) Solution combustion synthesis of nanoscale materials. Chemical Reviews, 116(23):14493–14586.
3. Mohammad H Elahinia, Mahdi Hashemi, Majid Tabesh, Sarit B Bhaduri (2012) Manufacturing and processing of NiTi implants: A review. Progress in Materials Science 57(5):911–946.
4. E Godlewska, K Mars, R Mania, S Zimowsk (2011) Combustion synthesis of Mg2Si. Intermetallics 19(12):1983–1988.
5. Olga Shuleshova, Dirk Holland-Moritz, Andrea Voss, Wolfgang Löser (2011) In situ observations of solidification in Ti-Al-Ta alloys by synchrotron radiation. Intermetallics 19:688–692.

Biography

Olga Kamynina, PhD Chemical Physics, is currently a Secretary for science at the Institute of Structural Macrokinetics and Materials Science, Russian Academy of Sciences (Chernogolovka, Moscow region). Her areas of interest include: Dynamics of phase and structure transformations during high-temperature processes in micro-heterogeneous systems; Mechanisms of combustion wave propagation in micro-heterogeneous media; Combustion synthesis of advanced materials; Product structure formation in conditions of combustion and thermal explosion; Influence of micro-gravity on combustion (SHS experiments in ISS); Dynamics and mechanisms of pore formation; New SHS-produced porous biomaterials

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