# $Ti_2AlN$ MAX PHASE OBTAINED BY FILTRATION COMBUSTION

**Kondakov A.A., Linde A.V., Studenikin I.A., Grachev V.V.**
Institute of Structural Macrokinetics and Materials Sciences RAS, Academician Osipyan str., 8, Chernogolovka, Moscow Region, 142432, Russia
kondakov_aleks@list.ru

At present time there are a lot of articles about investigations of binary systems gas–solid including such systems as titanium–nitrogen and aluminum–nitrogen. The logical continuation and development of these works is a transition to the investigation of filtration combustion of ternary systems. Ternary system titanium–aluminum–nitrogen is of scientific interest and practice usage of obtained combustion products. The scientific interest consists in experimental investigation of filtration combustion regularities of such system, in which several simultaneous competitive reactions are possible. In addition to two parallel reactions gas–solid, such as titanium–nitrogen and aluminum–nitrogen with formation of nitrides, the reaction between solid reagents titanium–aluminum with formation of intermetallic compounds is possible. In turn these compounds can react with nitrogen. Besides the formation of triplex compounds titanium–aluminum–nitrogen is possible too. These compounds behave to MAX phases and they possess unusual properties combination. On the one side they have high electric and heat conductivity, ability to the mechanical treatment as metals. On the other hand they possess high thermal stability and oxidation stability as ceramic materials.

The aim of the present work was to investigate the possibility of MAX phase synthesis in the ternary system titanium–aluminum–nitrogen in the mode of filtration combustion.

For preparation of initial mixture we used titanium powder (PTS-1) and aluminum powder (ASD-1). These powders were mixed in planetary ball mill during 20 minutes. The next step was pressing of cylindrical tablets with diameter 15 mm and height 50 mm. In some experiments we used mixture with green density. In this case this mixture was placed into the vessel of filter paper with the same sizes. In other experiments the initial mixture was exposed to thermal vacuum treatment into the quartz tube at 640°C during 60 minutes. During this process the consolidation of powders and the partial interaction of solid reagents with formation of intermetallic compounds with different composition were observed.

For measurement of combustion velocity and temperature the thermal couples WRe5/WRe20 were installed at known destination. Experiments were carried out in the bomb of constant pressure in the nitrogen atmosphere. Combustion was initiated by means of Ni-Cr spiral heated by electric current. The initial pressure was 0.5 MPa. The propagation of filtration combustion wave was fixed by video camera. Burnt out specimens were analyzed by means of X-ray phase analysis and scanning electron microscopy.

Video recording showed that the process character depends on density of initial specimens and presence or absence of previous thermal vacuum treatment. The external picture was changed from the uniform propagation of bright luminant front for specimens with green density to the irregular curved front for specimens after thermal vacuum treatment.

X-Ray phase analysis for a specimen after thermal vacuum treatment revealed that this product is multiphase and contains the next phases: $Ti_2AlN$, TiN, AlN, $TiAl_3$. A peak with maximal intensity corresponds to MAX phase $Ti_2AlN$.
Scanning electron microscopy revealed that microstructure corresponds to grains of MAX phase $Ti_2AlN$ with sizes from 1 to 5 μm located into the intermetallic matrix $TiAl_3$.

Therefore the first investigations showed the principal possibility of obtainment of MAX phase $Ti_2AlN$ at filtration combustion. In the nearest future we're planning to determine the optimal conditions for combustion synthesis of $Ti_2AlN$ MAX phase.