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Impact of aluminum concentration on the synthesis of highly pure Cr_2AlC MAX phase

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In recent years, MAX phases achieved significant attention from scientists for their promising practical applications and theoretical values. This fascinating class of materials are layered ternary carbides and nitrides having hexagonal crystal structure. MAX phases exhibit a unique combination of properties of both metals and ceramics such as high thermal and electrical conductivity, excellent machinability, good damage tolerability and superb thermal shock resistance, as compared to binary carbides and nitrides. However, the wide applicability of MAX phases restricts due to cost effective synthesis and their phase stability. In this study, we have successfully synthesized Cr_2AlC MAX phase through pressure less sintering route. The impact of aluminum content (10 – 50 mol%) on the phase formation and structural properties of Cr_2AlC has been investigated. It is observed that the purity of Cr_2AlC MAX phase can be enhanced by varying the aluminum content, even at lower temperatures (1200–1300°C), as compared to previously reported Cr_2AlC MAX phase (> 1300°C). The highly pure Cr_2AlC is obtained at 1300°C, when the aluminum content in 40 mol%. In addition, the crystallite size is found maximum (28.14 nm) and lattice strain (4.03 × 10-3) is minimum for highly pure Cr_2AlC. Also, oxidation kinetic analysis is performed to estimate activation energy (Eg) by following Kissinger-Akahira-Sunose (KAS) method. The MAX phase demonstrated high oxidation resistance and no mass gain is observed in the TGA curve below 700°C. In addition, two exothermic peaks are observed at ~ 700°C and ~ 1050°C. The former peak is associated the oxidation of excess aluminum present on the surface of MAX phase. While later peak represents the formation of Al_2O_3 layer over the surface MAX phase.

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