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Nitriding VI-group metals (Cr, Mo and W) in stream of NH_3 gas under concentrated solar irradiation in a solar furnace at PSA (Plataforma Solar de Almería)

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Abstract

Carbides and nitrides of *d*-group transition metals are classified as refractory hard material and their industrial importance has been recognized for long. In recent years, unique functionalities including catalytic function and superconductivity are discovered for this group of materials to raise serious attention of materials researchers and engineers to refractory carbides and nitrides as novel functional materials.

Synthesis of refractory carbides and nitrides demands high temperature reaction route to consume considerable amount of electricity or gas in conventional industrial process. In view of saving cost of such conventional energy, feasibility of using concentrated solar beam as heat source for synthesizing carbide and nitride has been investigated by the authors since 1997. After verifying usefulness of concentrated solar beam as heat source for carbide forming reactions, similar attempts of employing concentrated solar beam as heat source for nitride synthesis were initiated recently. After brief experimental verification of nitride synthesis for IVa group metal, Ti, and Vg group metals, V, Nb and Ta, in N_2 gas environment under irradiation with concentrated solar beam to 2000 °C, the authors decided to undertake nitride synthesis of VIa group metals, Cr, Mo and W, as well as of Fe in stream of ammonia (NH_3) gas as a nitriding medium under irradiation of concentrated solar beam at temperatures not exceeding 1000 °C.

NH_3 gas with suppressed extent of dissociation by flowing is defined empirically as uncracked NH_3 and it is proved to possess very high nitriding power to make synthesis of mono-nitride MoN of Mo coexisting with sub-nitride Mo and higher nitride Fe_2N of Fe possible under normal pressure condition that are not possible when chemically stable N_2 gas is used as a nitriding agent.

VIa-group metals including Cr, Mo and W are known to be highly resistant against nitriding. In the present report, results of nitriding in flowing NH_3 gas at a fixed flow rate 10 l/h (≈167 ml/min) under heating with concentrated solar beam for VIa-group metals, Cr, Mo and W, are summarized to demonstrate favorable effect of solar beam heating towards further enhancement of nitriding power of flowing NH_3 gas compared with the situation in conventional electric furnace in which visible light components except infra-red (IR) heat wave component are absent in the reaction system.

Keywords: Concentrated solar beam; NH_3 gas flow; Nitride; VIa-group metals (Cr, Mo, W)

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