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Single-step Synthesis of Molybdenum Carbide Nanoparticles by Wire Explosion Process

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Molybdenum carbide (MoC) is used extensively in many industrial applications especially as catalysis replacing the expensive noble metals. Nano sizing of the material provides high surface area for reaction. Many processes are used to synthesize MoC nanoparticles (NPs). Those techniques involve multiple steps and a specific choice of precursors with long preparation time. In the present work, MoC NPs were synthesized by adopting wire explosion process (WEP), in single step. WEP utilizes the joule heating of wire by injecting high magnitude pulsed current obtained by discharging high energy capacitor. In the process, the wire sublimates to vapour/plasma, reacts with ambient and gets cooled down in ms time, to yield oxide, nitride, carbide NPs depending on the ambient used. To control the phase and morphology of NPs, two parameters are defined in WEP: energy ratio, K (ratio of energy supplied to wire and sublimation energy of wire) and pressure, P of ambient gas.

We propose the synthesis of MoC NPs with Mo wire as starting material and to carryout explosion in the methane gas medium, which acts as carburizing medium, as well as coolant, to bring down the local temperature rise to a value lower than the melting point of the material. XRD, TEM, SEM and XPS were used to characterize the synthesized NPs. Pure MoC was synthesized for K = 5.8 and P = 170 kPa. Carburization is more for high K/pressure. For low pressure case, one has to provide more K to get complete carburization. XPS confirms the formation of MoC. Spherical NPs were obtained with least mean particle size of 20 nm. Particle size decreases with increase in K and/or decrease in P. Formation mechanism of metal carbide NPs by WEP, will be discussed based on thermodynamical aspects.

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