The effect of nano transition metals on microstructure and phase evolution of low carbon MgO-C refractories

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Abstract

In the present study, the effect of Iron Nitrate as catalytic precursor to in situ formation of nano-Fe particles in phenolic resin and microstructural evolution of MgO-C refractories has been investigated. Therefore, various samples according to matrix section formulation of low carbon MgO-C refractories (LCMCR's) with 0 and 6 wt% (Fe/Phenolic resin) were prepared and phase and microstructure changes after coking at temperatures 800-1400ºC studied by XRD and FESEM analyses. Based on attained results, iron nitrate transfer to Fe nano particles with 60-80 nm in diameter during firing in reduced atmosphere. In situ formed Fe nano-particles as catalytic agent promotes graphitization behavior of phenolic resins. Increasing temperature led to a more effective graphitization level. In addition, the different nano crystalline carbon shapes such as onion and bamboo like and carbon nanotubes (CNTs) were in situ formed. Phase and microstructure analysis of LCMCR's samples reveal that different ceramic whiskers such as MgO, $MgAl_2O_4$ spinel, Al_4C_3 and AlN formed after coking at 1000 ºC and the amount of whiskers phases significantly increased at higher coking temperatures. It was also clarified the presence of Fe nano-particles have effective influence on the formation of gases components and promote ceramic phases formation. Microstructural observation showed the graphitic carbons like carbon nano-tubes (CNTs) and ceramic whiskers mainly formed in the bonding phase between the aggregates according to the V-L-S and V-S growth mechanism.

Keywords: Fe nano particles, Catalyst, CNTs, Ceramic whiskers.