# MICROWAVE ACTIVATED COMBUSTION SYNTHESIS OF INTERMETALLICS IN THE CO-SI SYSTEM

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## ABSTRACT

This paper describes Microwave Activated Combustion Synthesis (MACS) of intermetallics of technical importance in the Co-Si binary system. These materials have important electronic applications as thin films. Bulk $CoSi_2$ is required for use as a target for the production of thin films in sputtering processes. Sputtering targets are generally processed either by a powder route, casting or mechanical working means. These silicides being brittle materials, the powder route is preferred.

The main objective of the present work was to explore the MACS process in order to synthesize single-phase $CoSi_2$ and CoSi, starting from powder reactants. Generally, intermetallic (silicide) formation is expected to be sluggish in the Co-Si binary system. Therefore, activation is required in a combustion reaction. Secondly, the MACS process was compared with other variants of the combustion synthesis process - e.g. thermal activation in a furnace (TACS), and conventional CS.

From the thermodynamic data, we found that while the formation of CoSi is moderately exothermic, that of $CoSi_2$ is sluggish. The powder compacts were ignited in a semi-industrial scale microwave furnace at 1 KW of power. Ignition occurred as soon as the temperature rose above 1223 K. The temperature peaked at approximately 1798 K, well above the melting point of the material. As a result, the sample was completely melted as the combustion wave progressed. $CoSi_2$ behaves in a significantly different manner. A higher ignition temperature is required, almost 1273 K. A maximum temperature of 1623 K is reached. Again, this is well above the melting and theoretical adiabatic temperatures. However, though partial melting is evident in the microstructure, $CoSi_2$, with a much lower adiabatic temperature, was not expected to be amenable to conventional processing. However, it was found that the reaction for $CoSi_2$ proceeded under conventional CS, but the combustion wave is erratic and occurred in spin mode, producing a non-uniform microstructure. Also, the initiation time was comparatively long, more than thirty seconds.

The samples were examined using x-ray diffraction (XRD) and scanning electron microscopy (SEM). The three different processing routes, MACS, TACS, and conventional CS produce different products. For CoSi, MACS and conventional CS produced identical pure products. TACS processing of CoSi produced an incomplete reaction with some silicon grains remaining in the matrix of CoSi.
Overall, samples synthesized by the MACS route were pure phase CoSi and $CoSi_2$.