Nanocomposite materials are gaining popularity because of their unique properties. High interfacial area and the interactions at these interfaces between the different constituents, result in properties that are not present in the individual bulk components. Mullite is one of such nanocomposite material and finds wide applications because of its high creep resistance and refractory properties. It is a naturally occurring aluminum silicate and is often produced synthetically because of its rarity. One common method of producing mullite is to mix aluminum oxide and silicon oxide particles in liquid solvents and then firing the mixture at temperatures as low as 1250 ^{o}C. However, removing the suspending liquid can be expensive in terms of both time and resources. Therefore, the objective of this work was to use dry mixing methods to improve the quality of mixing of alumina and silica for the purpose of reducing the temperature for mullite formation and to increase % conversion of a mixture to mullite.

Various environmentally friendly dry mixing methods have been used to prepare nanoparticle mixtures of alumina (d_p = 13 nm) and silica (d_p = 16 nm) at the stoichiometric ratio of 3:2 for the purpose of forming mullite at sintering temperatures above 1250 ^{o}C. One such method is Magnetically Assisted Impact Mixing, which uses sub-millimeter magnets propelled by oscillating magnetic field to mix the nanopowders. The quality of mixing, which was determined by Energy Dispersive X-Ray Spectroscopy (EDS) was correlated to the amount of mullite formed as measured by X-ray powder diffraction (XRD) and differential scanning calorimetry (DSC).

Preliminary results correlating the quality of mixing to the amount of mullite formed after firing at 1550^{o}C are shown below in Table 1. Mullite content was determined by quantitative XRD analysis using CaF_2 as an internal standard. The mullite content was correlated to the intensity of segregation (IOS), a mixing quality index proposed by Danckwerts [1], in order to demonstrate the effect of mixing on % of mullite formation. IOS ranges from 0 to 1, where 0 implies perfect homogeneity and 1 implies complete heterogeneity and was determined from EDS analysis. Lower IOS implies more uniform mixing and hence increases % conversion to mullite.

Table 1: Comparison of mixing quality, characterized by the intensity of segregation to the amount mullite formed at 1550 ^{o}C.

Sample	IOS	Mullite Content (%)
1	0.0017	~ 100
2	0.030	87
3	0.450	55

[1] Danckwerts, PV. The Definition and Measurement of some characteristics of Mixtures. Applied Science Research. 1952: 3;A, 279-296.