ABSTRACT

Ceramic composites based on silica sand-alumina (SS-A) and silica sand-magnesia (SS-M) have been successfully synthesized to study their physical, phase, and thermal expansion characteristics. This study was established to enhance added value of the silica sand from Tuban, Indonesia. The composites were prepared by means of solid state reaction route. The characterized physical properties include diameter shrinkage, porosity, and density of the bulk samples. Phase compositions within the samples were evaluated after X-ray diffraction data collection and analysis. The coefficient of thermal expansion (CTE) of the composites were calculated semi-theoretically by applying Halpin-Tsai formula and measured by means of thermo-mechanical analysis (TMA). Generally, additions of alumina and of magnesia on the composites increase the density and decrease the porosity of the composites. SS-A composite did not experience any reaction sintering phenomenon like SS-M did. The reaction sintering in the SS-M composite is indicated by the presence of new phases formation, such as forsterite, enstatite, and clinoenstatite as a consequence of the presence of SiO$_2$ and MgO. In SS-A system, CTE values decreased for the SS-A950, SS-A1050, and SS-A1150 composites, but increased for the SS-A1250 composite. The phase complexity within the SS-M composite resulted in their CTE values being not always increasing. Furthermore, in general, the physical, phase, and thermal expansion of SS-A and SS-M composites showed good stability after several thermal cyclic tests. In addition, micrography and elemental mapping analyses indicated that shape, as well as size, of quartz and cristobalite are different. Besides that, distribution of periclase, forsterite, enstatite, and clinoenstatite within the composite is more homogenous than α-alumina distribution.

Keywords: ceramic composite, silica sand, alumina, magnesia, reaction sintering, thermal expansion.