**Supplementary Information**

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**Fig. S1. FESEM micrographs of (a) MZM/0.5GO, (b) MZM/1GO and (c) MZM/1.5GO nano-composites.**



**Fig. S2. FESEM micrographs of as-sintered composites: (a) MZM, (b) MZM/0.5GO, (c) MZM/1GO, and (d) MZM/1.5GO nano-composites; EDS analyses of (e) area A in (c) and (f) area B in (d).**

Fig. S2 shows the FESEM micrographs and related EDS analyses of sintered MZM/GO nano-composites with different amounts of GO. It can be seen that in all materials, the eutectic phase is along the grain boundaries in a discontinuous manner and triple junctions. Since GO has high aspect ratio, when high amounts of GO encapsulate into MZM matrix, they are accumulated in the matrix of composites within grain boundaries and near the grain. However, GO has been distributed in a uniform way in MZM-based composites when low contents of GO load into the matrix. The EDS spectra confirm the presence of Mg, Mn, Zn, C, and O, which further confirms the presence of GO in MZM matrix (areas A and B).