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High-biobased-content UV-curable oligomers derived from tung oil and citric acid: Microwave-assisted synthesis and properties

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Ultraviolet (UV)-curing technique has been widely applied in modern industrial areas such as coatings, inks, and adhesives due to their "5E" advantages, i.e. efficient, energy saving, enabling, economical, and eco-friendly. However, due to the dramatic fluctuation of oil prices, greenhouse effect from CO_2 emission, and serious environmental problems, much efforts have been devoted into the preparation of UV-curable materials from renewable resources such as carbohydrates, plant oils, and rosins.

In this study, two novel UV-curable oligomers (TMCG1 and TMCG2) from tung oil and citric acid were synthesized *via* microwave technology and confirmed by FT-IR,^{1}H NMR, and ^{13}C NMR. The total reaction time was only 30 min, and the obtained oligomers showed high biobased contents (over 60%). Furthermore, a series of UV-curable coatings were constructed by copolymerizing the oligomers with a biobased reactive diluent (GA) from guaiacol. The resulting UV-cured materials achieved both high biobased content and high performance. For instance, the cured TMCG1 film with 10% of GA showed a biobased content of 72.4%, tensile strength of 16.6 MPa, glass transition temperature of 74.1 ^{o}C, maximum thermal degradation temperature of 437.2 ^{o}C, adhesion of 2 grade, pencil harness of 2H, and flexibility of 2 mm.

In general, the biobased UV-curable coatings show great potential to be applied in the fields of coatings like wood coatings, and the combination of bioresources, microwave technology, and UV-curing technology indicated in this work could provide a "green + green + green" solution for the coating industry.

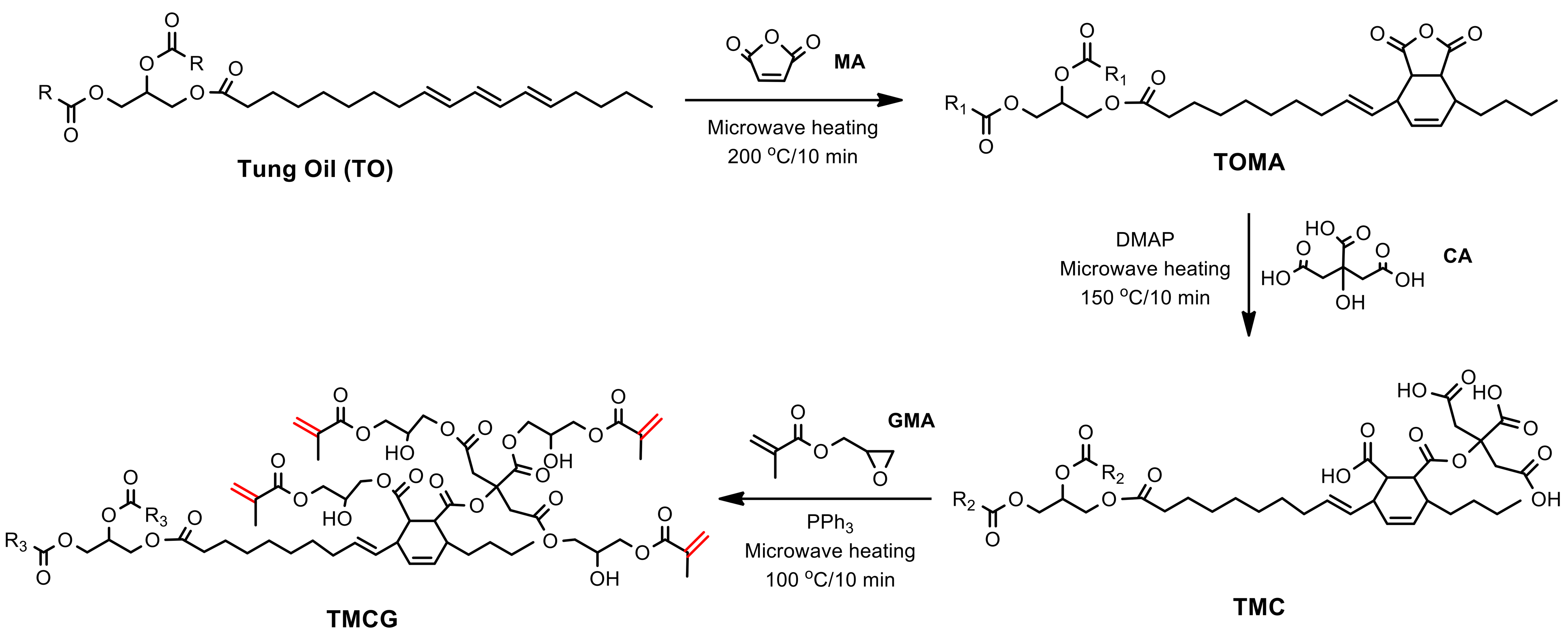

Fig. 1. Synthesis route for TMCG from tung oil (TO) and citric acid (CA).

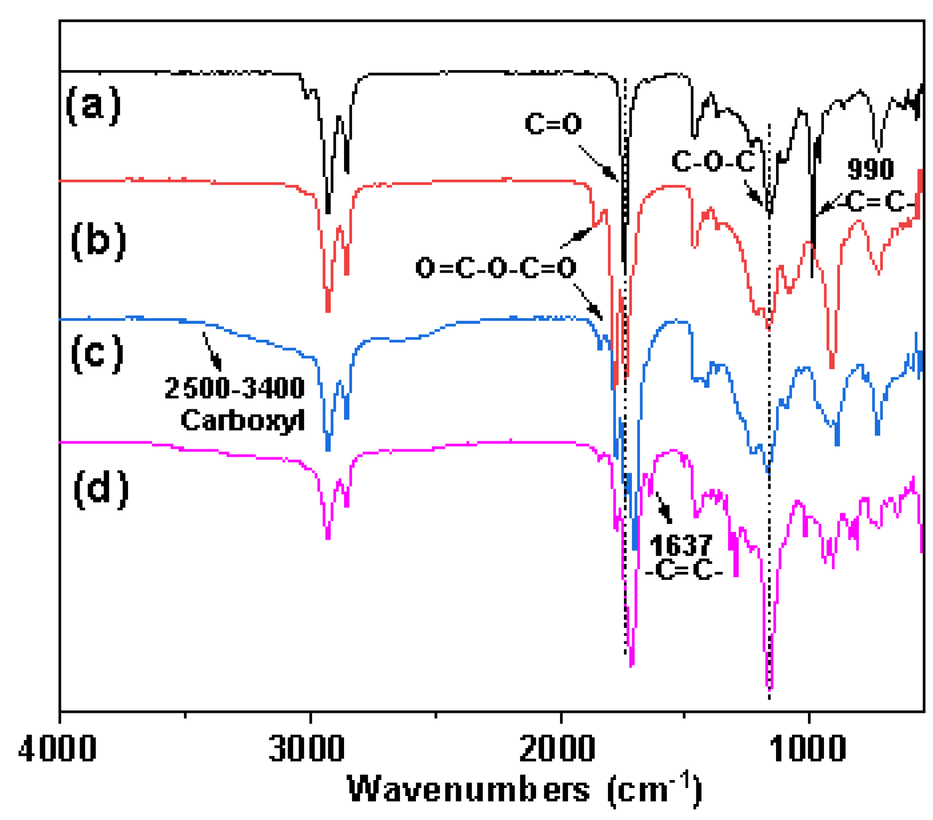

Fig. 2. FT-IR spectra of (a) TO, (b) TOMA2, (c) TMC2, and (d) TMCG2.

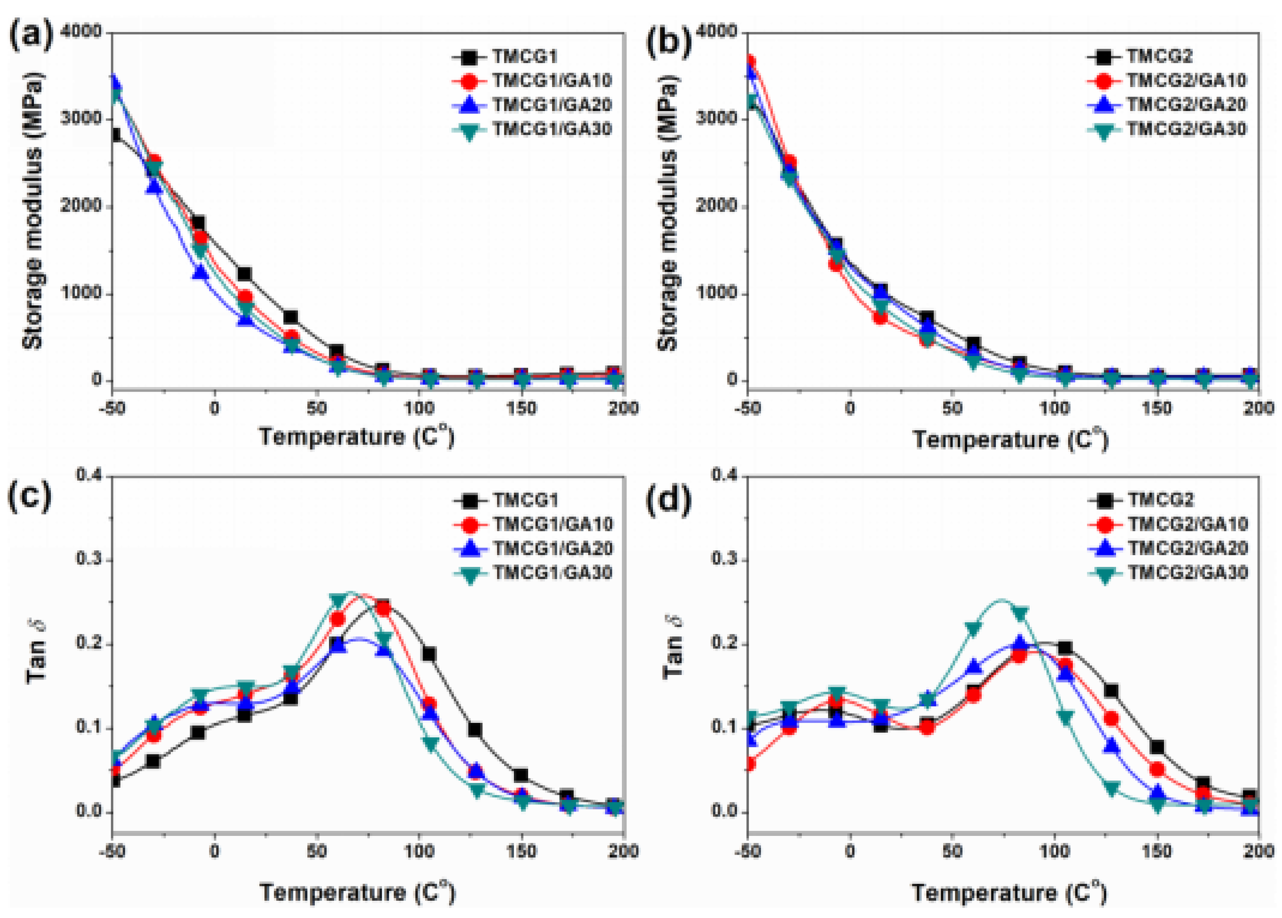

Fig. 3. Storage modulus and loss factor of the UV-cured TMCG/GA materials.

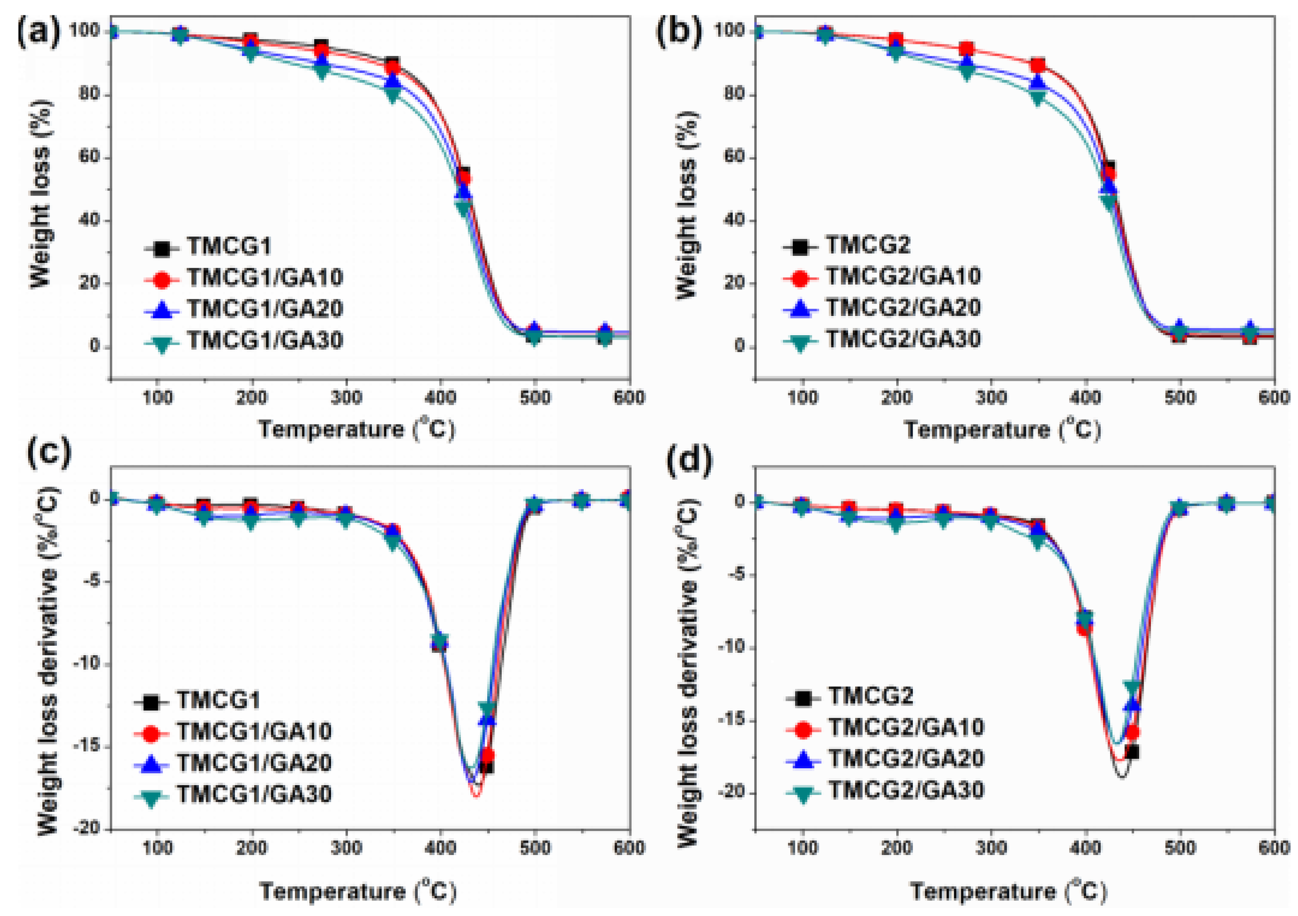

Fig. 4. TGA curves and their derivatives of the UV-cured TMCG/GA materials.

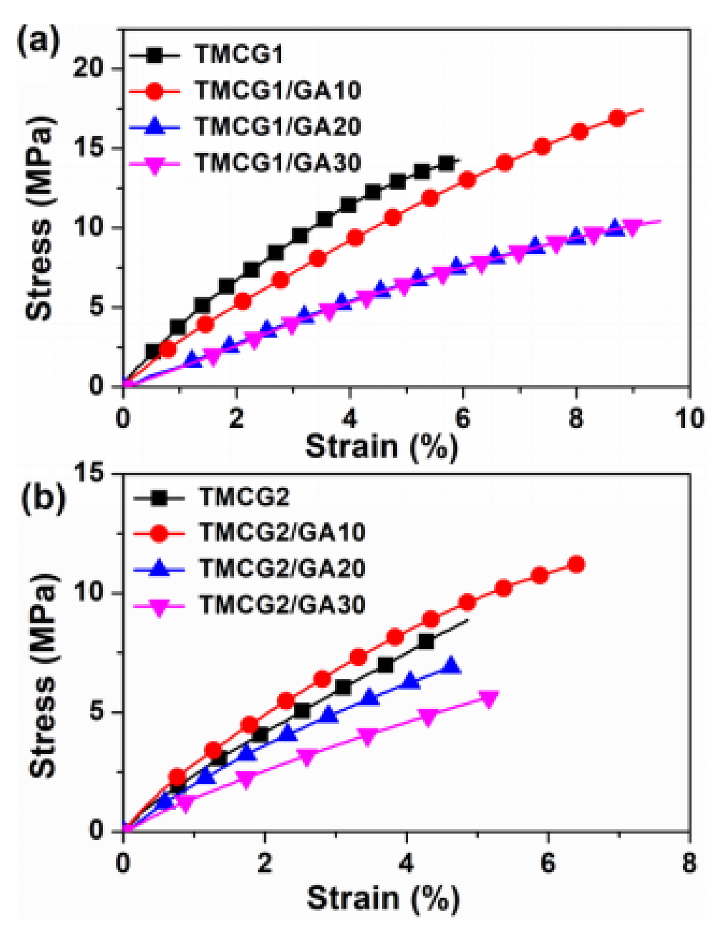

Fig. 5. Typical tensile stress–strain curves of the UV-cured TMCG/GA materials.

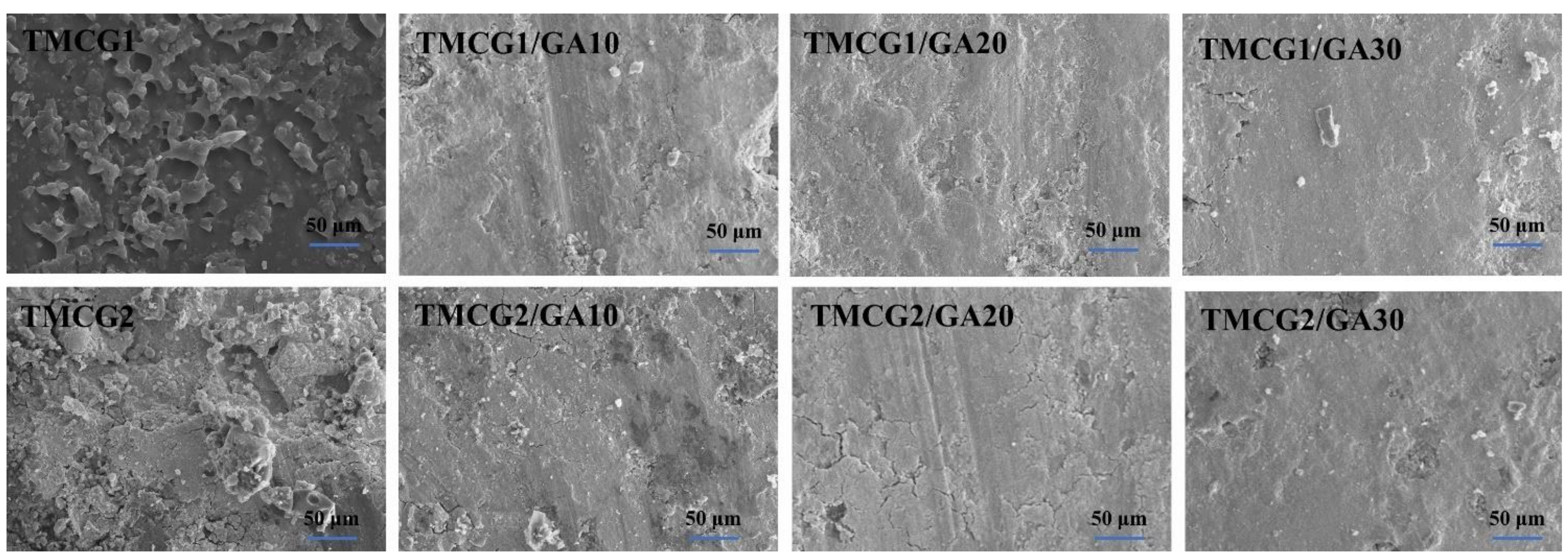

Fig. 6. SEM images of the cured TMCG/GA materials.

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