POWDER-BASED PROCESSING OF HIGHLY-LOADED PLATELET-REINFORCED COMPOSITES

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Conventional processes commonly used for the fabrication of composites with high volume fraction of reinforcing elements usually require the infiltration of monomers that are subsequently consolidated into a continuous polymer matrix. Such infiltration step often leads to long processing times and limits the choices of materials that can be used as soft polymer matrices. In this work, we present a new infiltration-less route in which a co-suspension of organic/inorganic powders is assembled through vacuum-assisted magnetic alignment and the resulting composite consolidated by uniaxial hot pressing at temperatures close to the melting point of the polymer phase. [1] We demonstrate that the fabrication process of thermoset- and thermoplastic-reinforced composites containing up to 50% in volume of aligned reinforcing platelets can be significantly simplified using this infiltration-less method (Figure 1a). Consolidation of thermosets matrices through hot pressing of assembled powder mixtures is achieved by employing polymers containing dynamic covalent bonds as crosslinking points in their molecular structure. As illustrated in Figure 1b, incorporation of 50% in volume of reinforcing platelets within dynamic polymer matrices enhances the flexural modulus and flexural strength by 14-fold and 3-fold as compared to the pure polymer, reaching values as high as 13 GPa and 90 MPa, respectively. As expected, the strain at rupture decreases from 3.0% to 0.8% upon addition of brittle ceramic platelets. These results demonstrate the potential of using infiltration-less routes to enable the fabrication of high-performance platelet-reinforced composites with high volume fraction of reinforcing ceramic particles and polymer matrices that are difficult to be infiltrated using conventional methods.

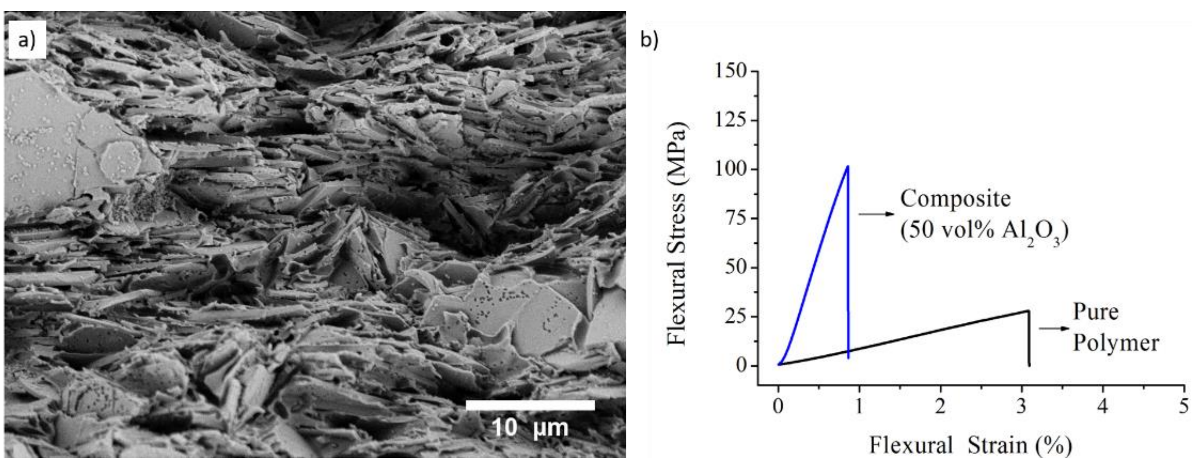

Figure 1 – a) Scanning electron microscopy image showing the fractured surface of a composite containing 50 vol% of reinforcing ceramic platelets embedded within a continuous dynamic polymer matrix . b) Representative stress-strain curves comparing the mechanical performance in flexural mode between the pure dynamic polymer matrix and the its composite containing 50 vol% of aligned reinforcing ceramic platelets.

References:
[1] M. Grossman et al., Advanced Materials 2016, 29 (8).