Supplementary Information (SI) for Journal of Materials Chemistry A.

Supporting Information

An energy efficient and sustainable approach to structural health monitoring in carbon fiber composites: harnessing sound-induced vibration with $Ti_3C_2T_x$ MXene/AgNPs modified P(VDF-TrFE) sensors

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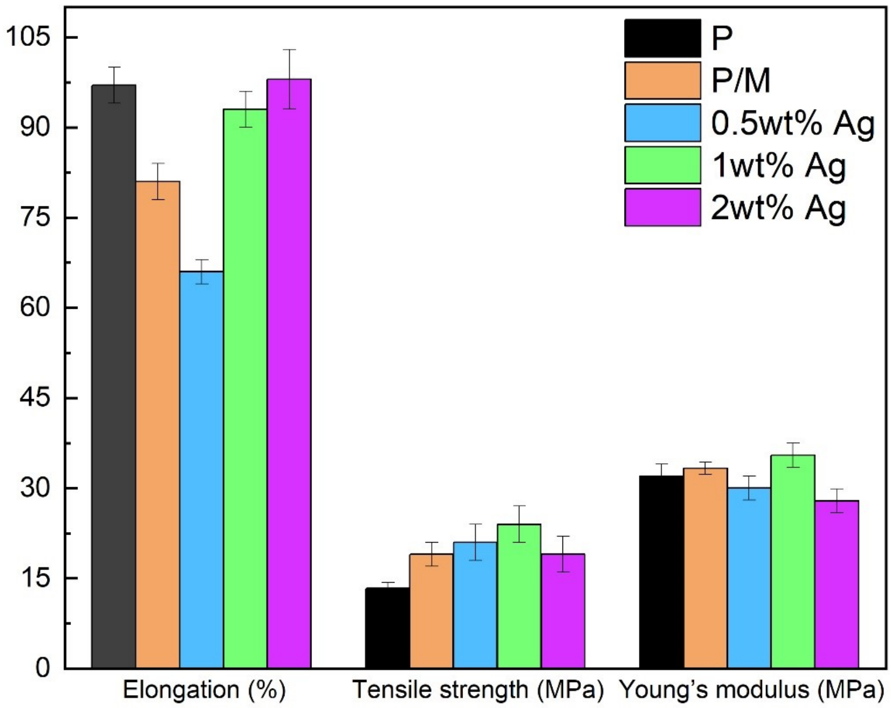

Fig.S1 Comparison of mechanical properties of nanocomposite fibers with MXene and different concentration of AgNP

Piezoelectric Force Microscopy (PFM) investigations were performed using a MultiMode 8 (Bruker, USA). For these investigations, all nanofibers were deposited on flat substrates prepared from Au-covered mica. The internal lock-in amplifier was used to detect the piezoresponse signal, with conductive Pt/Cr-coated silicon tips. To measure the ferroelectric-induced dipole orientation, the PFM signal was recorded without the poling process in the AFM system. The piezoelectric d_{31} coefficient, in terms of electromechanical response, was measured as a function of the applied AC bias, which was applied between the tip and the electrode deposited on the samples bottom surface. The change in PFM amplitude was measured for an applied AC bias ranging from 2 to 10 V. Calibration was performed using periodically poled lithium niobate ($LiNbO_3$, Bruker, USA).

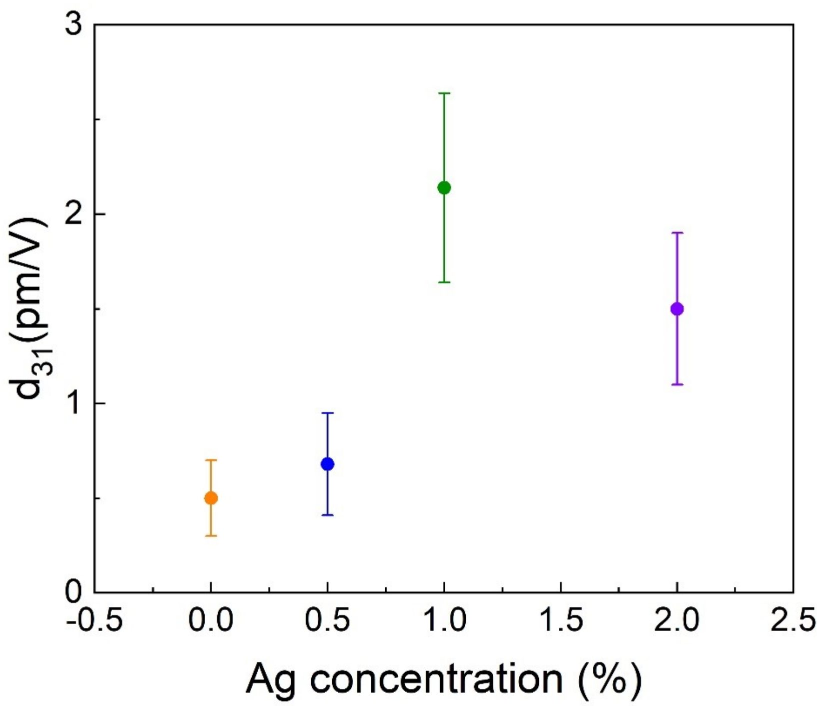

Fig.S2 PFM results for the average piezoelectric coefficient (d_{31} mode) of nanocomposite fibers with various AgNP concentrations.

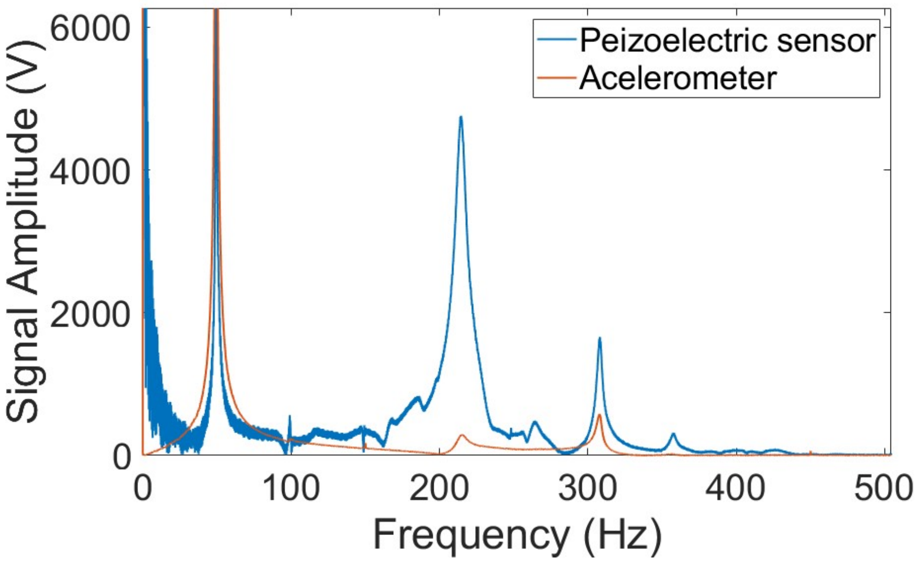

Fig.S3 The frequency spectrum of the 2.4 mm thickness showing natural frequencies of vibration at 49.7, 214.5, and 308.2Hz

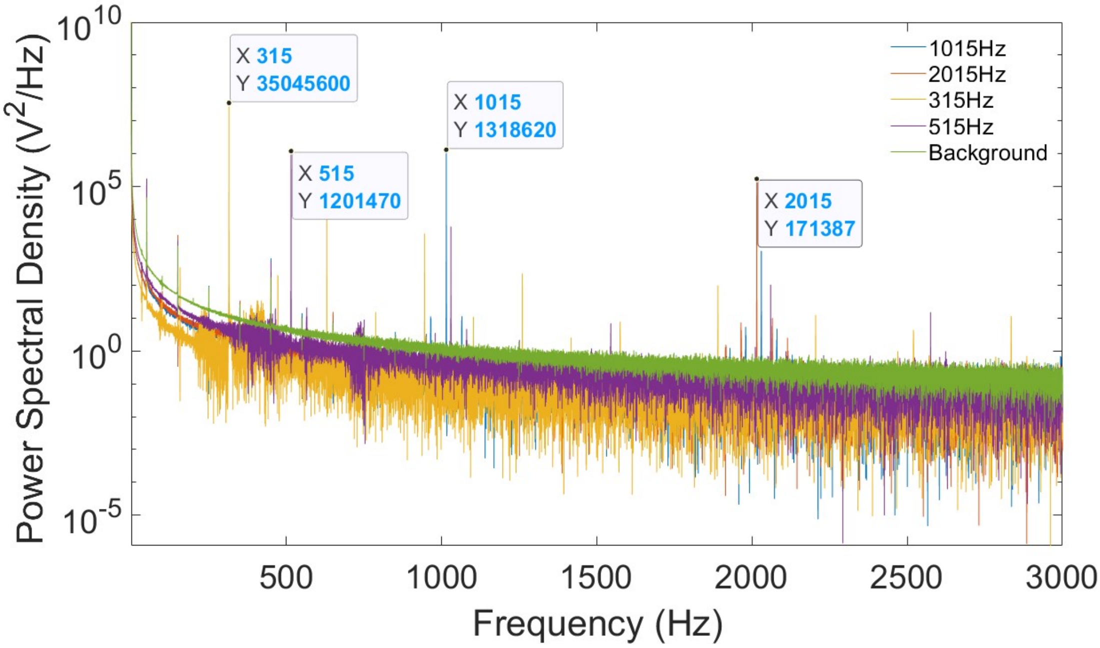

Fig.S4 The power spectral density of the piezo sensor with beam 0.44 mm thickness excited by sound at 315, 515, 1015, 2015 Hz, the peak due to vibration of the beam (labelled) and background power levels

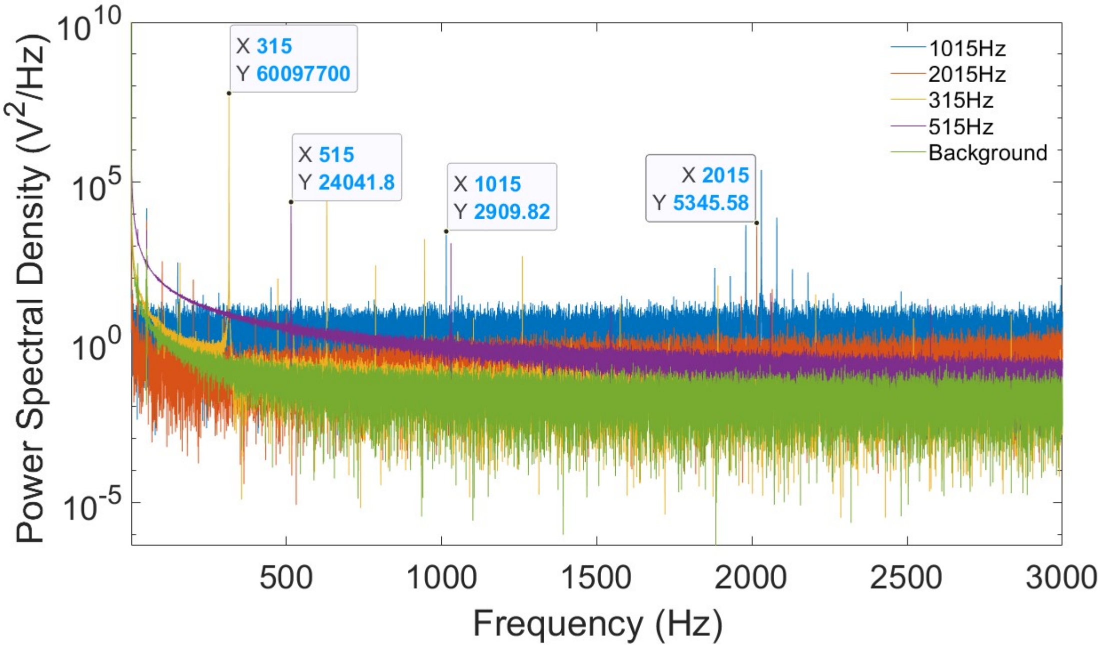

Fig.S5 The power spectral density of the piezo sensor with beam 2.4 mm thickness excited by sound at 315, 515, 1015, 2015 Hz, the peak due to vibration of the beam (labelled) and background power levels

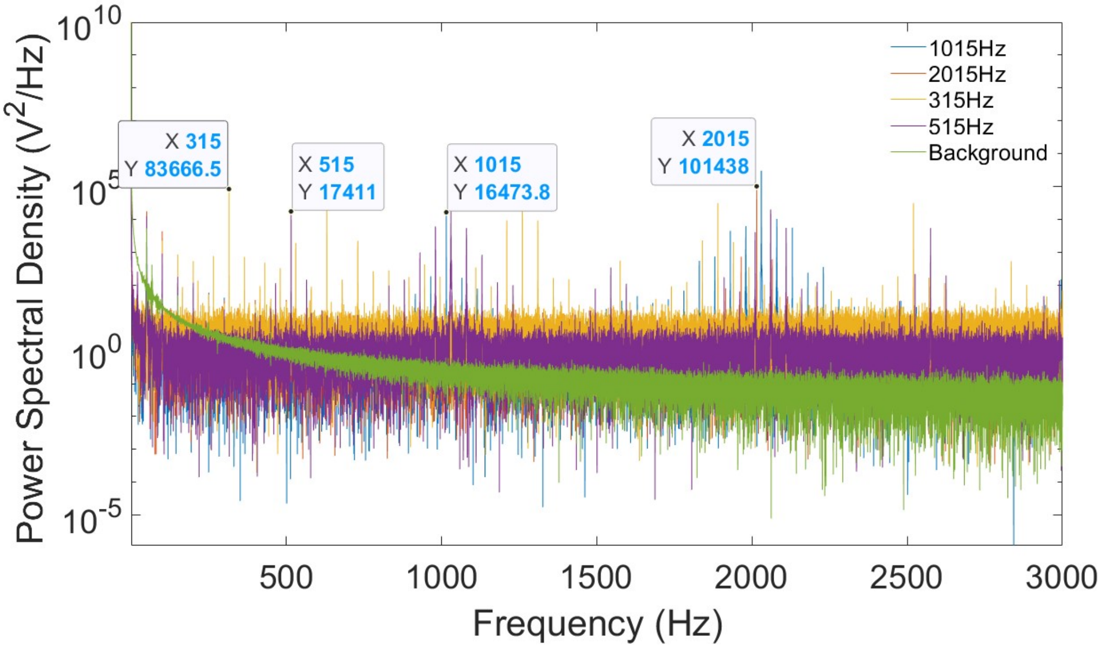

Fig.S6 The power spectral density of the piezo-sensor with beam 3.15 mm thickness excited by sound at 315, 515, 1015, 2015 Hz, the peak due to vibration of the beam (labelled) and background power levels

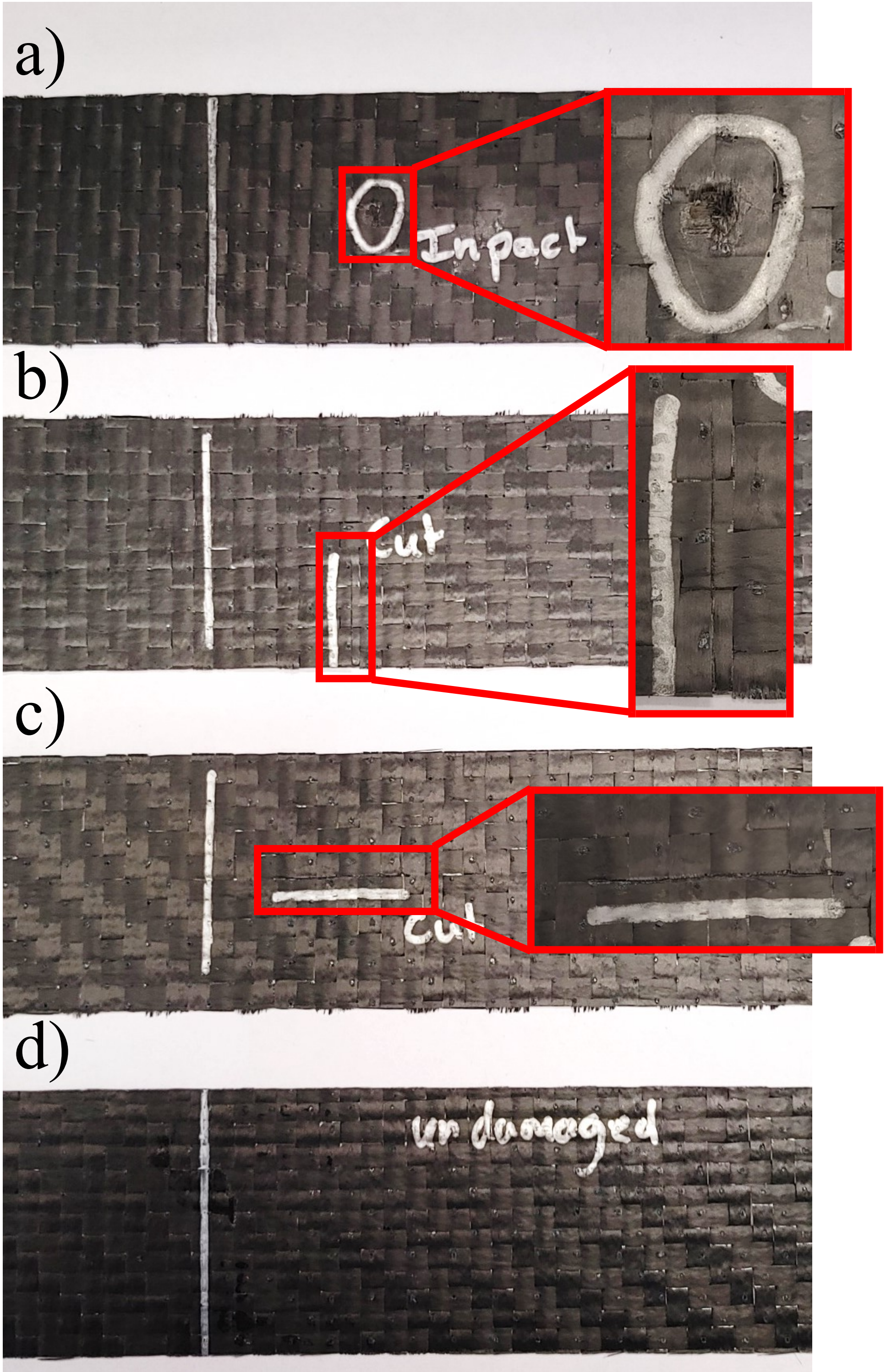

Fig.S7 Photographs of carbon fiber composite with a zoom in image of the damage caused to the beam, a) impact damage, b) transverse, c) longitudinal, and d) the undamaged composite