Effect of TiO_2 Topical Treatments on Concrete and Asphalt for On-Road Microplastic Pollutant Removal

SUMMARY REPORT

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EFFECT OF TIO_2 TOPICAL TREATMENTS ON CONCRETE AND ASPHALT FOR ON-ROAD MICROPLASTIC POLLUTANT REMOVAL

Introduction:

Microplastics have permeated our environment and on-road deposition (road-associated microplastic or "RAMP") is the leading cause of both tropospheric and oceanic contaminations. Applications with TiO2 provide a solution to this growing issue. TiO2 is capable of catalyzing the evaporation process of microplastics into consumable (vegetative uptake) carbonate CO3 and H2O, removing the airborne and estuarial threat(s). The purpose of this study was to determine how effective the TiO2 added to certain road maintenance products from Pavement Technology (PlusTi), UV radiation and relative humidity (RH) are with respect to minimizing polystyrene microspheres similar in relative size and chemistry to on-road microplastic pollutants such as tire-wear and brake-pad wear debris. In other words, how much volume could be reduced by adding TiO2 into a roadway microenvironment increasingly overrun by non-exhaust emissions (NEE) from vehicles. A growing problem which will only be exacerbated by electric vehicle (EV) adoption.

Results:

The twenty-four (24) hour volume loss found in each sample can be found in Table [1]. This volume loss represents the smallest diameter found in the SEM images per sample. There is evidence of 100% volume loss in the SEM images which can be observed in the right most picture in Figure [1] and more easily in Figure [2].

Table 1: 24 – Hour Irradiation

Sample #	Test Duration (hrs)	P_{LED} (W)	$D_{initial}$ (nm)	D_{final} (nm)	$V_{initial}$ (nm^3)	V_{final} (nm^3)	Volume Loss (%)
1	2	110	100.0	37.4	523599	27282	94.8
2	24	110	100.0	15.7	523599	2026	99.6

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In Figure [1] the microspheres are diminished in size as irradiation time increases. In the testing series 100nm (diameter) polystyrene microspheres were tested with TiO2 and UV radiation (375nm). The results conclude large volume loss of polystyrene after 24 hours of irradiation at 110W. The microsphere diameters were measured using a scanning electron microscope (SEM).

A timelapse via SEM images is provided:

Figure 1: Irradiated Samples (0, 2, and 24 – Hour Irradiation – Left to Right)

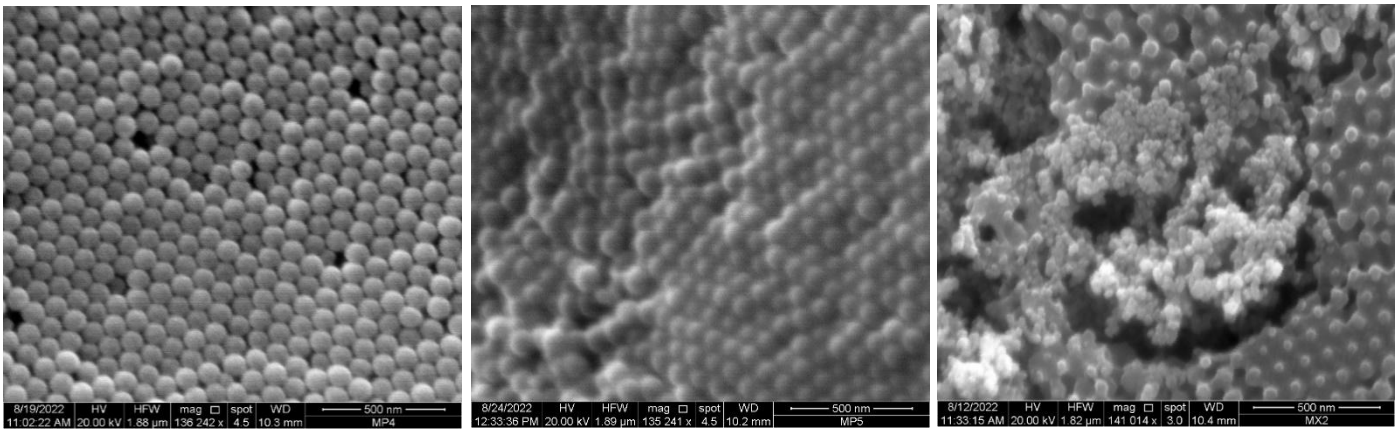
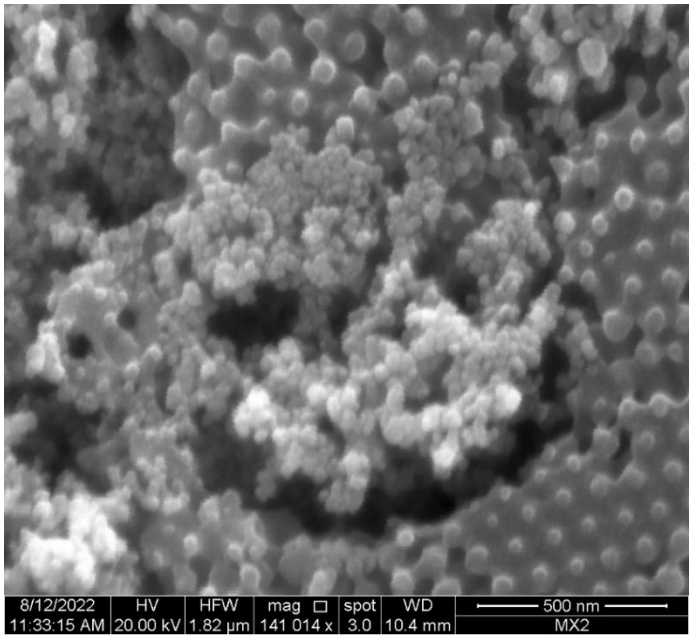


Figure 2:



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Conclusion:

The images taken with the SEM are direct evidence of the rapid and substantial evaporation of microplastics with the aid of TiO2 as a catalyst. Several samples were successfully tested and analyzed resulting in a substantial volume loss over time (specifically a change in microsphere diameter).

References:

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