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Is nanoplastic a genuine concern? How a technological breakthrough became a threat for the environment

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Introduction. The single use LDPE (Low Density PolyEthylene) bags that are massively produced and discarded throughout the world, end up in terrestrial and aquatic ecosystems. There are enough data to sustain the negative impact of LDPE on the environment (both fauna and flora), however, many speculate that LDPE could be degraded to nano-dimensions, but no certain data is provided in this regard.

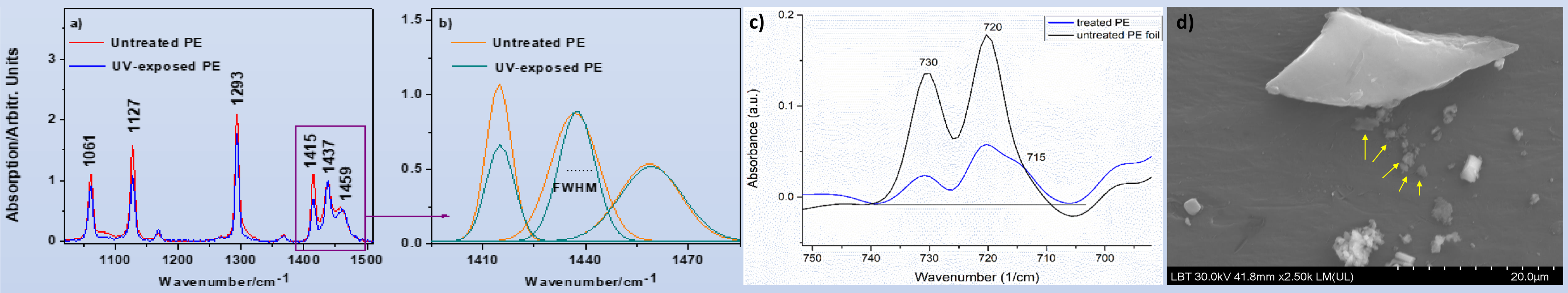

Figure 1. (a) the experimental Raman spectra in the “fingerprint region” from 1000 to 1500 cm^{-1}; (b) comparative display of Gaussian profiles of the δ(CH_2) and ω(CH_2) modes. The spectra are baseline-subtracted and normalized to the 1437 cm^{-1} band for the purposes of CH_2 deformation modes direct comparison; (c) b) 750-690 cm^{-1} FTIR spectral domain; (d) SEM micrograph depicting nano-plastics (arrows).

Materials and methods. A transparent LDPE bag was used in the current experiment and two directions were followed:

1) the bag was cut into small pieces (1 cm × 20 cm) and left for 10 days under UVC light, to observe if it is possible to obtain nanoplastics. The as formed plastics were incubated with *Escherichia coli* bacteria and *Atrospira platensis* cyanobacteria to determine if any interaction occurs.

2) the bag was cut intro 1 cm^2 pieces, sterilized under the UV lamp for 30 minutes, and incubated with *Enterococcus faecalis* bacteria.

The samples were analyzed through Scanning and Transmission Electron Microscopy (STEM), Raman Spectroscopy, Fourier Transformed InfraRed Spectrometry, and Confocal Microscopy.

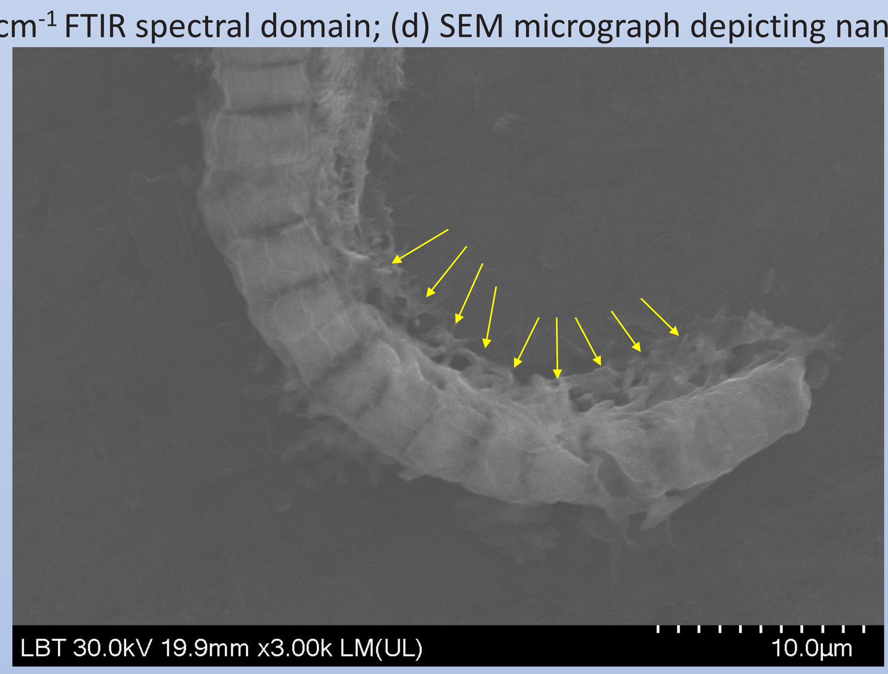

Figure 2. SEM macrograph of *Atrospira platensis* attached to macro LDPE, forming exopolysaccharides (arrows).

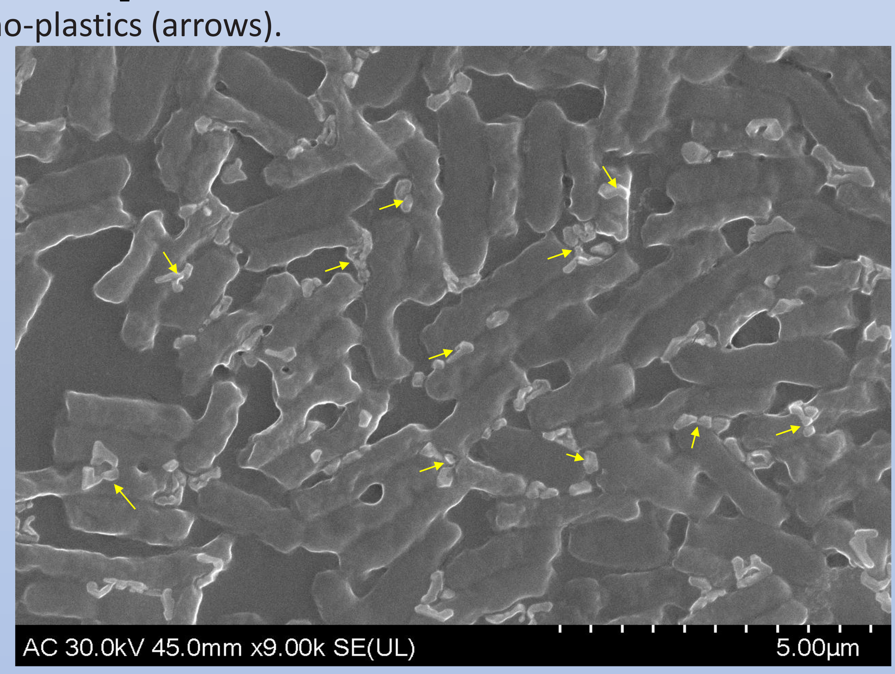

Figure 3. SEM macrograph of *E. coli* interacting with nano-LDPE (arrows).

Results. Nanoplastics were obtained from direct exposure to UVC light after only 10 days (Figure 1) and moreover, the plastic suffered slight alterations compared to untreated samples.

A short-term exposure of 72 h is sufficient to negatively influence the photosynthetic rate of *Atrospira platensis* (Figure 2). The nanoplastics dyed with NileRed were left to interact with *E. coli* and small fragments seemed to get attached, and most probably were ingested by the bacteria (Figure 3-6).

The SEM images confirmed that this strain produced biofilms on LDPE. After one day, *Enterococcus faecalis* did not produce biofilm, but after 5 and 10 days the biofilm was clearly formed. After 5 days there was a significant increase in bacterial growth (Figure 7).

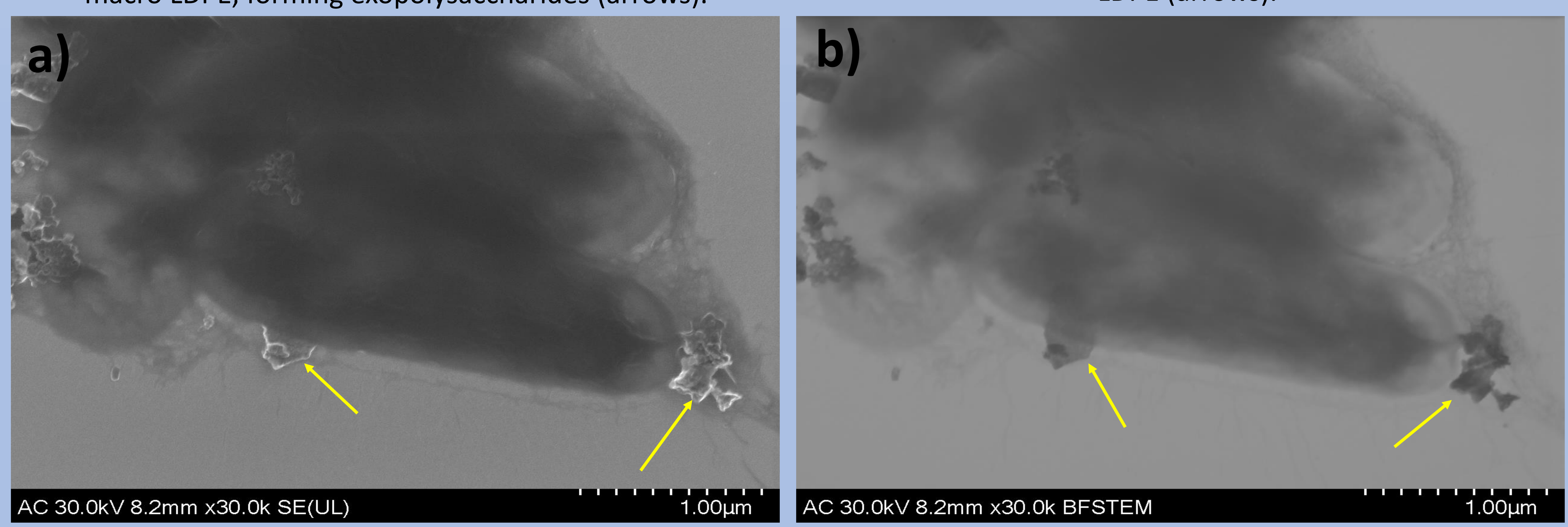

Figure 4. STEM macrographs of *E. coli* interacting with nano-LDPE (arrows); (a) SEM, (b) TEM.

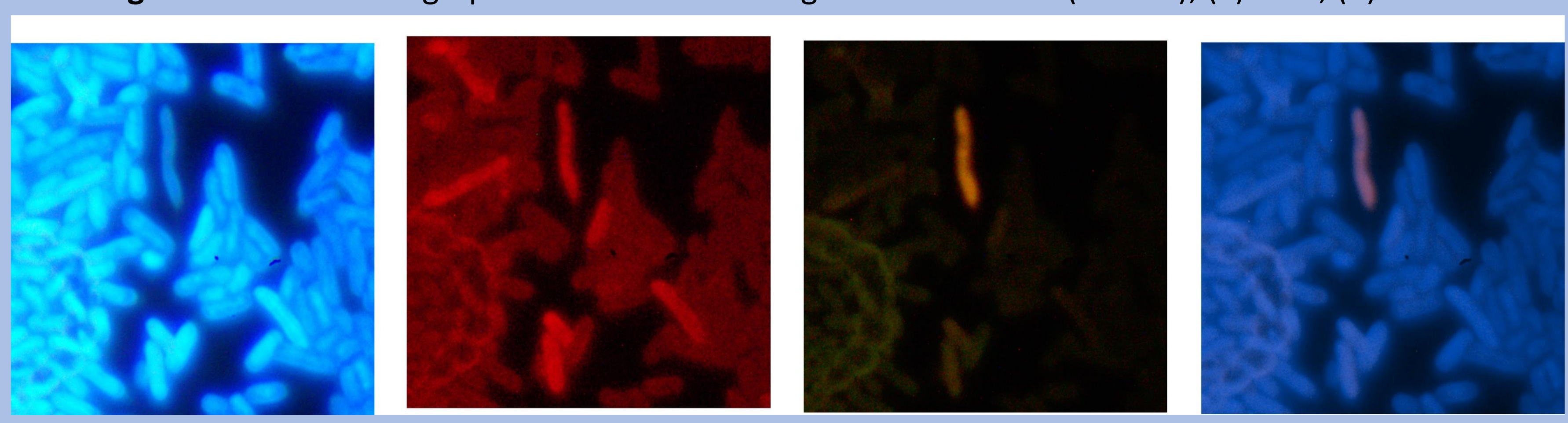

Figure 5. Fluorescence microscopy image of *E. coli* interacting with nano-LDPE (red).

Conclusions. After only 10 days a macro-LDPE was transformed into small nanoplastic under UVC light. These fragments interacted with the microorganisms chosen for this study, at ultrastructural levels and the mode of action is to be elucidated in the near future. Considering that LDPE was released into the environment less than 50 years ago, a series of concerns are raised regarding the irreparable damages that may have occurred.

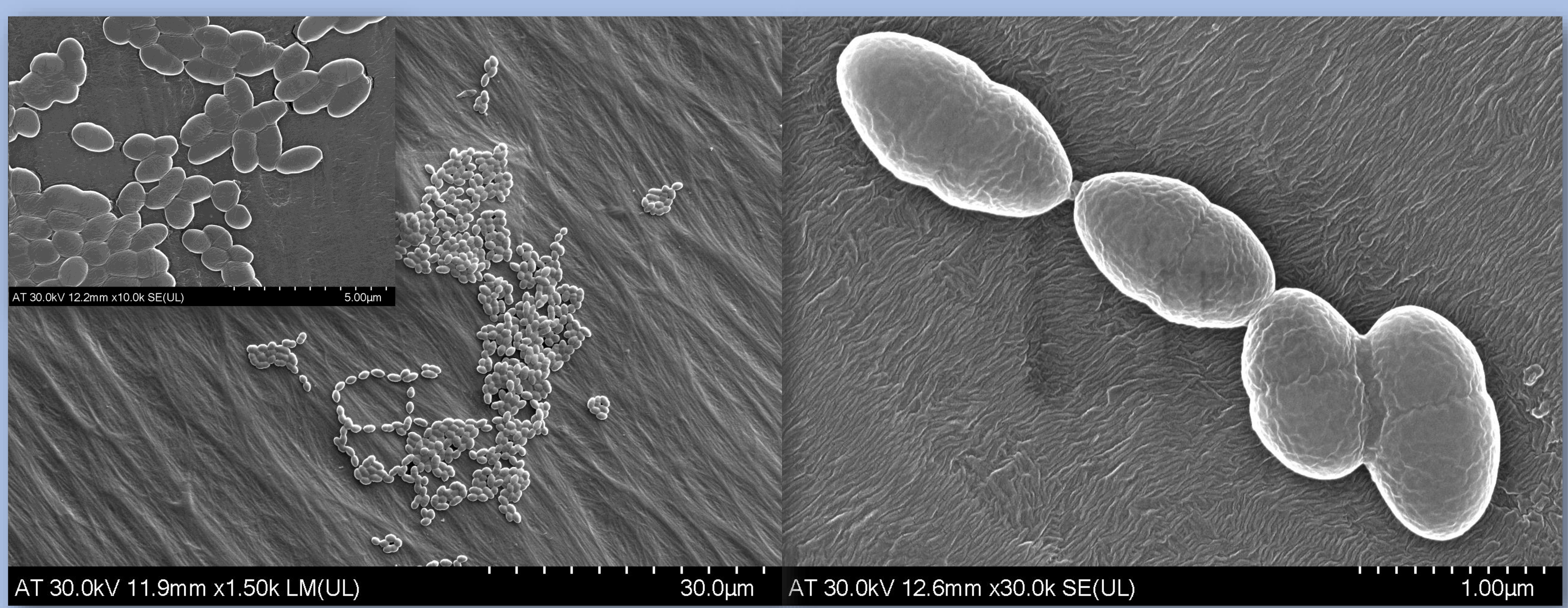

Figure 7. SEM micrographs of *E. faecalis* forming a slight biofilm on the surface of macro LDPE

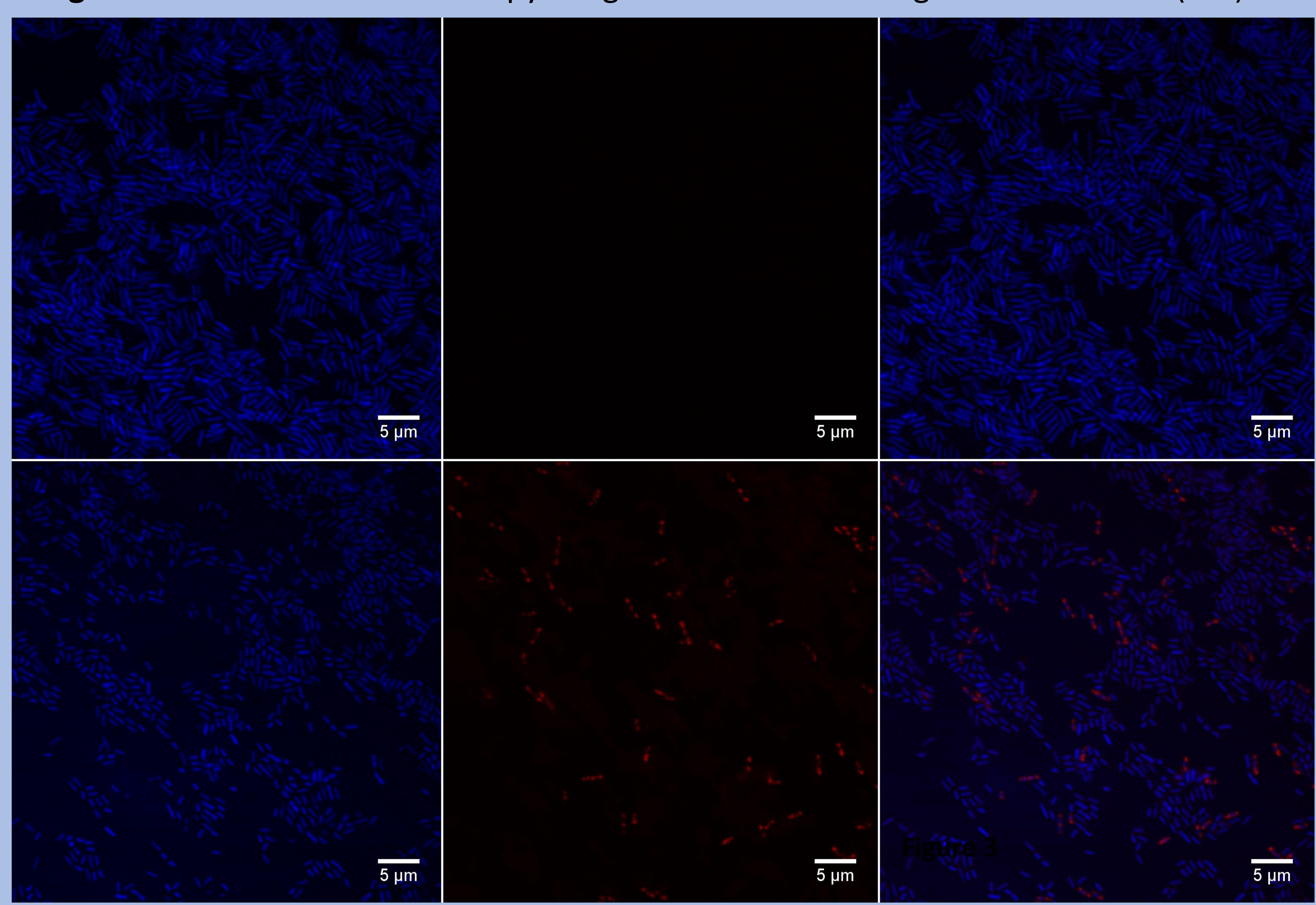

Figure 6. Confocal microscopy image of *E. coli* interacting with nano-LDPE (red).