**Figure S1.** (a) Raman spectra of single-walled carbon nanotubes. (b) Atomic force micrograph of monolayer dispersed graphene in tapping mode. The lateral width and thickness is 2 μm and 1.3 nm, respectively.
**Figure S2.** (a) Fourier transform infrared (FTIR) spectra of pure PE, PE-CNT, and PE-graphene. The doublet peaks at 720-730 cm\(^{-1}\) were used to determine (b) % crystallinity of pristine PE and PE crystallized on nanostructured carbon (CNT and graphene) using equation:

\[
X = 100 - \frac{1 - I_a / I_b}{1.233} \times 100
\]

Where, \(I_a\) and \(I_b\) represents the peak intensity, and is determined from the bands at 730 and 720 cm\(^{-1}\), respectively [Reference: G. Zerbi, G. Gallino, N. Del-Fanti, and L. Baini, ‘Structural depth profiling in polyethylene films by multiple internal reflection infra-red spectroscopy’, Polymer 30, 2324-2327 (1989)].

The crystallinity of PE after crystallization experiment was not affected significantly and remained crystalline after the experiment and is present as polymer crystals on CNTs as disks.