

88h Universal Scaling for Polymer Degradation in Turbulent Flows

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Flow-induced polymer chain scission (or degradation) is a ubiquitous phenomenon that involves breaking of covalent bonds at the atomic scale due to the stress generated by fluid flow at the continuum scale. This phenomenon has implications in turbulent drag reduction, polymer filtration and shotgun genome sequencing. Fundamental understanding of the relationship among flow strength, scission and the resulting molar mass of a polymer chain is vital to the design of these applications. Our flow characterization experiments in cross-slot and contraction geometries demonstrate that previous scission scaling experiments that were thought to be in the laminar regime were in fact affected by turbulence. We reconcile inconsistencies in these scission experiments and prior theories by means of the hypothesis that polymer scission in turbulence is driven by the Kolmogorov cascade. We thereby establish a universal scaling for polymer chain scission in turbulence that is well supported by available experimental data. We further use the scission scaling to obtain scission-induced bounds on maximum drag reduction.