Abstract Submitted
for the MAR15 Meeting of
The American Physical Society

Side Chain Engineering of Naphthalenediimide-Based N-type Polymer for High-Performance All-Polymer Solar Cell near 6% Efficiency CHANGYEON LEE, HYUNBUM KANG, WONHO LEE, TAESU KIM, KI-HYUN KIM, KAIST, HAN YOUNG WOO, PNU, CHENG WANG, Lawrence Berkeley National Laboratory, BUMJOON KIM, KAIST, PUSAN NATIONAL UNIVERSITY (PNU) COLLABORATION, LAWRENCE BERKELEY NATIONAL LABORATORY COLLABORATION — Despite the attractive features of all-polymer solar cells (all-PSCs), i.e., enhanced absorption coefficients, the tunability of their energetic and chemical properties and their thermal and mechanical stabilities, they still face the great challenge of having significantly low power conversion efficiency (PCE) values of only 3-5%. The prominent origins of the poor efficiency of all-PSCs are the undesirable features of the bulk-heterojunction (BHJ) blend morphology including the phase-separated large-scale domain size, reduced ordering of the polymer chains. Tuning side alkyl chains of conjugated polymers is an effective route for manipulating the blend morphology in BHJ type solar cells. However, the role of side chains in all-PSCs is poorly understood. Herein, we report high-performing all-PSCs with 5.96% efficiency by developing a series of naphthalenediimide (NDI)-based polymer acceptors with different alkyl side chains. We demonstrated that the use of the PNDIT with hexyldecyl side chains produced highly-ordered polymer stackings with strong face-on geometry and at the same time, forming the optimal BHJ morphology with finely separated phase domains, all of which contributed together to induce well-balanced $\mu e/\mu h$ ratio and generate efficient all-PSCs with PCEs near 6%.

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Date submitted: 13 Nov 2014 Electronic form version 1.4