Supporting information

1. The working principle of HHIC reactor

Hyperthermal Hydrogen Induced Cross-linking (HHIC) is a method capable of selectively breaking C-H or Si-H bonds without breaking other bonds using hyperthermal molecular hydrogen. In this method, a hydrogen plasma is maintained and protons are extracted with an electric field to accelerate them to an appropriate kinetic energy. The protons enter into a drift zone to collide with molecular hydrogen in gas phase. The cascades of collisions produce a high flux of hyperthermal molecular hydrogen, which is many times higher than the flux of protons extracted from usual hydrogen plasma. The nominal flux ratio of hyperthermal molecular hydrogen to proton is controlled by the hydrogen pressure in the drift zone, and by the length of the drift zone. The extraction energy of the protons is shared by these hyperthermal molecules so that average energy of the hyperthermal molecular hydrogen is controlled by extraction energy of the protons and the nominal flux ratio. Since the hyperthermal molecular hydrogen projectiles do not carry any electrical charge, the flux of hyperthermal hydrogen can be used to engineer surface of both electrical insulating products and conductive products. When this method of generating a high flux of hyperthermal molecular hydrogen is applied to bombard organic precursor molecules (or silicone, or silane molecules) with desirable chemical functionalities on a substrate, the C-H or Si-H bonds are cleaved preferentially due to the kinematic selectivity of energy deposition from the hyperthermal hydrogen projectiles to the hydrogen atoms in the precursor molecules. The induced cross-linking reactions produce a stable molecular layer having a controllable degree of cross-linking and retaining the desirable chemical functionalities of the precursor molecules. HHIC is thus a versatile research tools for surface engineering of polymeric materials.

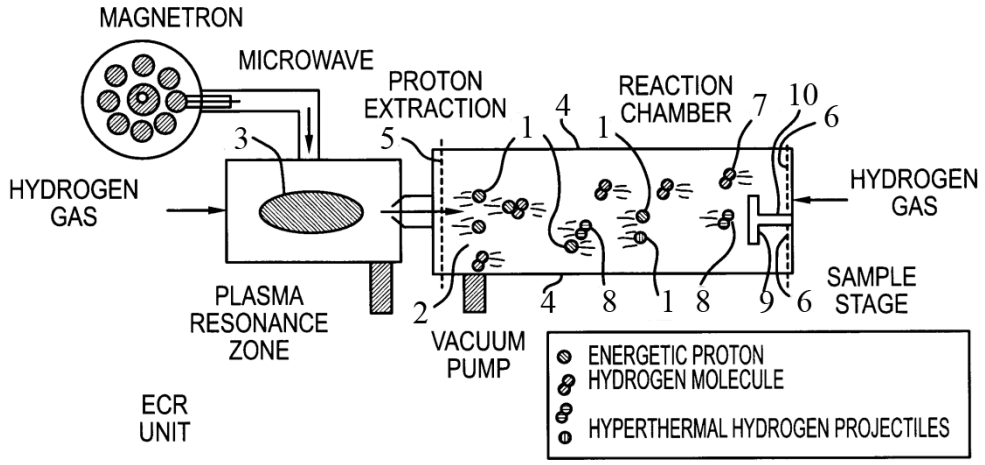

Figure 1S. Schematic diagram illustrating the HHIC working principle. Microwave ECR is employed as the plasma source in this model. (Labels in Figure 1S: 1-protons; 2-drift zone; 3-microwave window; 4-vacuum drift chamber; 5, 6-grid electrodes; 7-hydrogen molecules; 8-hyperthermal neutral molecular hydrogen projectile; 9-substrate surface; 10- substrate holder)

2. Modification of separator by UV treatment

One 400 W lamp (OSRAM Company, Germany) of maximum wavelength of 365 nm was installed on a bracket in a UV-irradiation instrument. The light intensity on the sample surface was about 55 mW/cm^2 measured by a UV-A radiometer (Photoelectric Instrument Factory of Beijing Normal University, China) with a single channel. 5 wt. % photo initiator (Benzophenone, BPO) was added into the PEO solution. According to the same spin coating process (6000 rpm, 30 s), the PEO-cotaed separator was prepared. The samples were exposed on the platform for 60 s.Figure 2S and 3S show the variations of apparent morphology and mechanical characteristics of the pristine and PEO-coated separators treated by HHIC and Ultraviolet. As can be seen from the digital photos, apparent folds appeared in the PEO-coated separator treated ultroviolet. And the apparent morphology of PEO-coated separators treated by HHIC was the same as that of the pristine one. So the results of the digital photos demonstrate that the HHIC treatment process is a nondestructive surface modification method. Also the results of the mechanical characteristics

proved the same phenomenon.

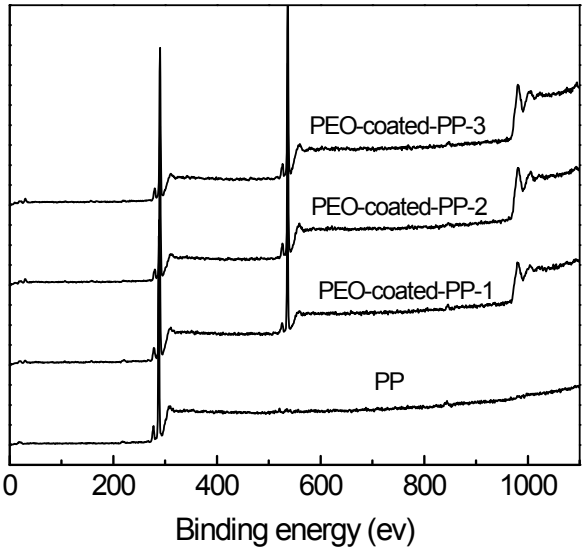

Figure 2S. XPS spectra of PP separator and its modified PP separators. PEO-coated PP separator 1, 2, and 3 correspond to PEO-coated PP separator without any treatment, HHIC treated PEO-coated PP separator before and after solvent washing, respectively.

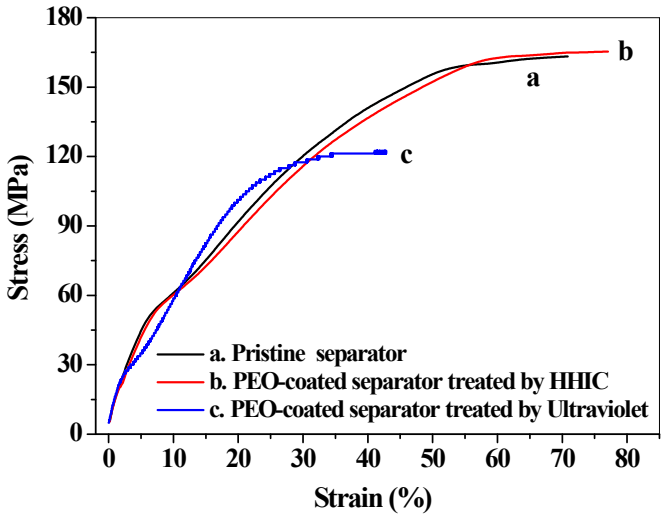

Figure 3S. Stress-strain curves of (a) pristine separator, (b) PEO-coated separator treated by HHIC and (c) PEO-coated separator treated by UV.

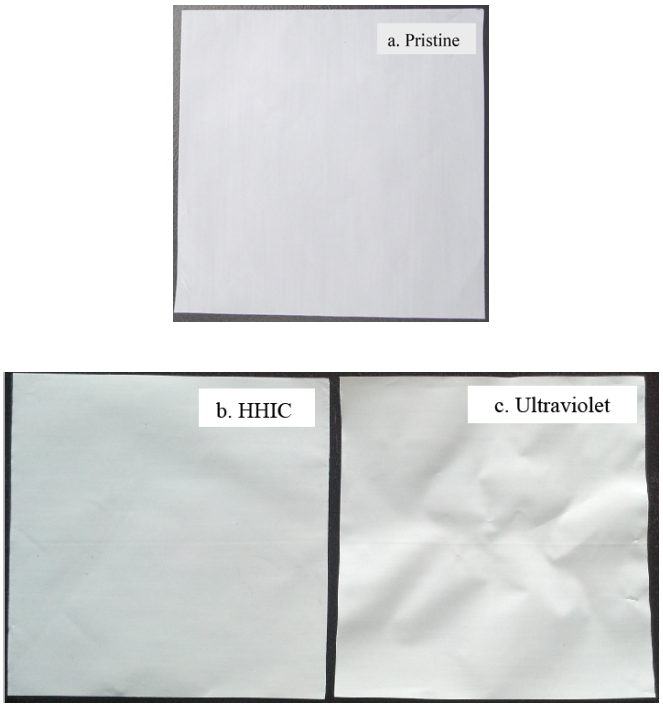

Figure 4S. Photographs of (a) pristine separator, (b) PEO-coated separator treated by HHIC and (c) PEO-coated separator treated by UV.