Supporting Information

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SI Materials and Methods

Origami Paper Testing. Origami paper was used to simulate delicate neonate skin. Strips of paper tape (3M Micropore Medical Tape), plastic tape (3M Transpore Medical Tape), and RL tape were applied to orange origami paper that was taped to the laboratory bench. To ensure even fixation, tape was applied using a 10-pound hand roller (ChemInstruments). One end of each strip of tape was wrapped around a metal ruler. The metal ruler was rapidly pulled, peeling all of the tape strips from the paper. Ripped portions are white and intact regions remain orange. The experiment was performed to test how incorporating a RL intermediary layer alters the damage induced by rapid, emergency removal.

Ninety-Degree Peel Testing. Because medical tapes are typically removed by peeling, 90° peel testing was performed to quantify adhesive parameters relating to tape removal. Peel testing was performed in accordance with PSTC guidelines (1). Tape was peeled away from a polished 304 stainless steel plate, or self-tested on ventral human forearm skin, at a 90° angle at a rate of 5 mm/s on an ADMET eXpert 7600 single-column mechanical tester equipped with a 90° peel-testing fixture. Average peel force was calculated by averaging peel force data (n = 3) acquired at a peel distance of 5–10 cm in all cases reported in this study. Maximum peel force was calculated by identifying the maximum force reached during the peel test. High-speed video of backing peel was captured using Dino-Lite Digital Microscope Pro using DinoCapture 2.0 software for image analysis. Individual frames were analyzed to track the position of the crack front as a function of time. Crack propagation across RL-coated surfaces and within laser-etched lines perpendicular to the peel direction (0.5 mm/s) were averaged separately to arrive at average crack propagation speeds.

Macroscale RL Strip–Backing Peel Testing. To elucidate the relationship between RL-coated fraction and peel strength, strips of RL-coated PET were laser cut to widths of 25%, 50%, and 75% of the full width of the tape (25 mm). Strips of RL-coated PET were placed in the center of 25-mm-wide strips of PET. Each combination was then peeled at 90° from the polished stainless steel plate, while monitoring force as a function of peel distance. Trials were performed in triplicate to quantify average and maximum peel force as a function of percentage of the contact line width, composed of the adhesive PET backing (with the remainder being RL coated).

RL Micropatterning. To micropattern the RL-coated PET, patterns were drawn on CorelDRAW Graphics Suite X5 (Corel). The pattern was etched using a 30-watt VersaLASER VLS2.3. To etch the RL making partial thickness cuts (∼20 μm) into the backing material, the laser-cutting speed was set to 100%, power to 10%, and pulses per inch to 1,000. Absorption of focused laser light disrupts intermolecular bonds, fracturing or vaporizing the material. Based on the depth of penetration, which is a function of the absorption of the material at the wavelength of the laser, intermolecular bond strength, power of the laser, laser cutting speed, and spot size, it can be used to etch or cut through the thickness. To cut through the full thickness of the backing material, the power was set to 50%, and other settings were maintained. Alternatively, sandpaper-roughened surfaces were mechanically established by hand along the width of the tape to create microscale divots in the RL coating.

Commercial Plastic Medical Tape RL Micropatterning. To demonstrate the three-layer tape design on a commercial backing material used in neonatal care, plastic tape (3M Transpore Medical Tape) was soaked in ethanol for 12 h to swell the adhesive layer. The adhesive layer was then mechanically abraded, leaving the backing. The backing was then coated in RL and micropatterned as described.

Micropatterned Backing-Surface Characterization. To quantify the microfeature sizes created by laser etching and sandpaper roughening, samples were analyzed by scanning electron microscopy and profilometry. Samples of laser-etched and sandpaper-roughened backings were analyzed on a Zeiss Ultra55 field emission scanning electron microscope (Carl Zeiss) equipped with energy-dispersive spectroscopic elemental analysis.

Carbon, oxygen, and silicon levels were quantified in regions between laser-etched lines and within the lines. As well, elemental levels were detected in and between mechanically abraded grooves. Between etched and abraded lines, silicon content was higher than within the lines, indicating that laser etching and mechanical abrasion removes the siloxane RL exposing the underlying PET.

Two- and three-dimensional surface analysis was performed on a Tencor P-10 Surface Profilometer (KLA-Tencor) equipped with a 2-μm-radius diamond-tipped stylus.

Neonatal ET-Tube Fixation Adhesion Testing. Because many medical tape–removal injuries occur during ET-tube removal, sheer-adhesion parameters were quantified to determine the comparative strength of adhesion between quick-release and commonly used medical tapes. Uncuffed neonatal ET tubes (Smiths Medical) were affixed to a polished stainless steel plate by experimental and control plastic or paper tapes. One end of ET tube was pulled at a rate of 5 mm/s from the stainless steel plate in the direction of the adhesive plane, while recording shear force as a function of pull distance. Maximum shear force was calculated by identifying the maximum force reached during each test.

To test normal adhesion, ET tubes were affixed to a polished stainless steel plate and peeled at 5 mm/s to adhesive bond failure at a 90° angle while monitoring force. Maximum-adhesive normal force was calculated by identifying the maximum force reached during each test.

Probe-Tack Testing. To quantify the effects of talcum "baby" powder neutralization on the residual adhesive left by quick-release tape, a 1-cm-diameter aluminum probe was brought into contact with adhesive adhered to a flat, parallel aluminum sheet at a speed of 1 mm/s until reaching a target compressive force of 3 N. The probe then dwelled in contact with the adhesive for 30 s, before being pulled away at a speed of 1 mm/s while monitoring tack force as a function of distance. Tensile-fracture strength was calculated as the maximum tack force measured during each test normalized to the cross-sectional area of the probe (0.8 cm^2).

Residual-Adhesive Quantification. To compare the amount of adhesive left after removal of common and quick-release medical tapes, 44-cm strips of each tape were applied to preweighed pieces of aluminum foil using the 10-pound hand roller. The tape strips were then removed and the aluminum foil sheets were weighed. The difference in mass was normalized to the cross-sectional area of the applied tape to yield values of residual adhesive mass per square centimeter.

Statistics. For single comparisons, an unpaired Student *t* test was used. For multiple comparisons, ANOVA was performed with the Tukey's honestly significant difference (HSD) test at significance levels of 95%. Error bars in bar graphs represent the SD.

1. Pressure Sensitive Tape Council, *Test Methods for Pressure Sensitive Adhesive Tapes* (Pressure Sensitive Tape Council, Naperville, IL), 15th ed.

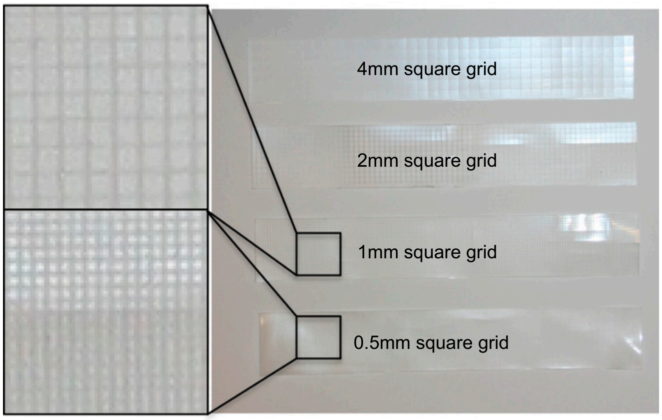


Fig. S1. Photograph of laser-etched square grid lines in RL-PET backings labeled with the grid line spacing. Insets show 5× magnification on 1-mm (*Upper Left*) and 0.5-mm (*Lower Left*) square grids.

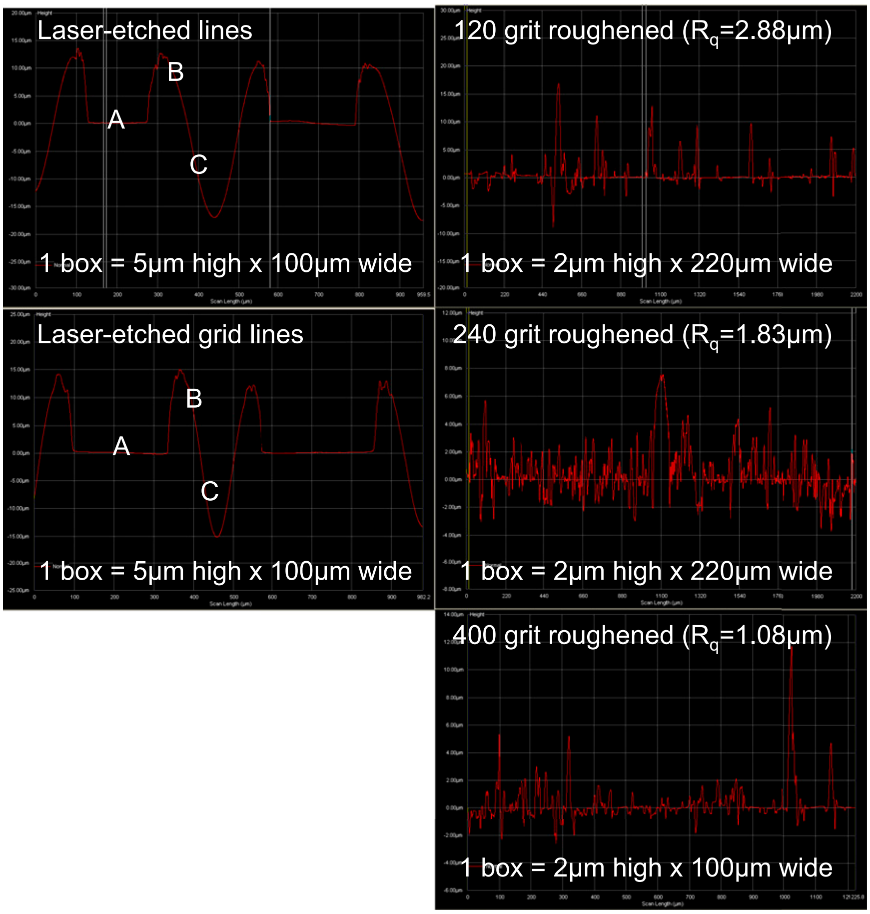


Fig. S2. Exemplary 2D optical profiles of laser-etched and sandpaper-roughened backing layers. For laser-etched samples, "A" highlights the surface of the RL layer. "B" marks 10- to 15-μm mound-shaped surface features created by the settling of residue of the laser-etching process and from slight curvature of the RL film induced by laser etching. "C" marks 15-μm-deep, V-shaped laser-etched grooves. Sandpaper-roughened samples show increasing rms average roughness (R_q) decreases with increasing grit (decreasing particle size). The RL layer is 0.5–0.8 μm thick; therefore, both laser-etching and sandpaper abrasion fully remove the RL layer, exposing the underlying PET to expose micron-scale adhesive sites.

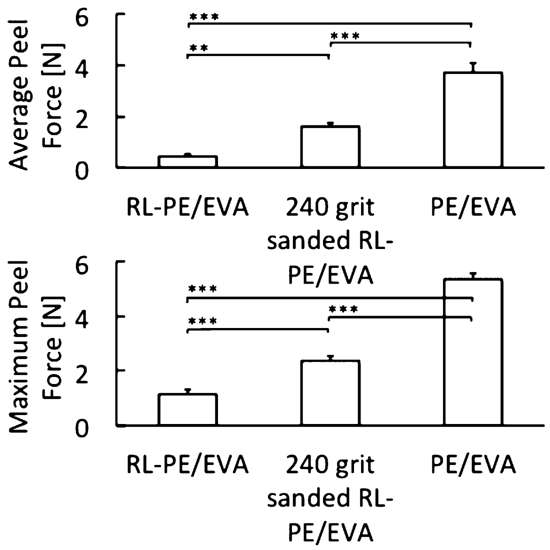


Fig. S3. To examine the potential for the quick-release medical tape approach to be applied to commercially used backing layers, the adhesive layer was removed from commercially available plastic [polyethylene–ethylene vinyl acetate (PE/EVA)] tape. PET/EVA was coated with RL (RL-PE/EVA), and samples were sanded with 240-grit sandpaper (240-grit sanded RL-PE/EVA). Compared with PET, uncoated PE/EVA exhibits less average peel force, and RL-coated PE/EVA exhibits a greater average peel force. The overall trend of the PET backing is preserved, because the microscale PE/EVA features exposed by mechanical abrasion of the RL coating enable tuning of the backing-layer peel force between the RL-coated backing and adhesive. Peel testing was performed in accordance with PSTC guidelines. All plots show $n = 3$ (mean ± SD). $^{*}P < 0.05$; $^{**}P < 0.01$; $^{***}P < 0.001$.

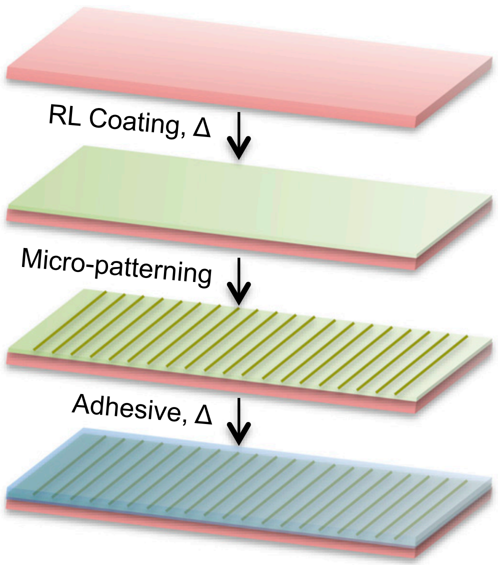
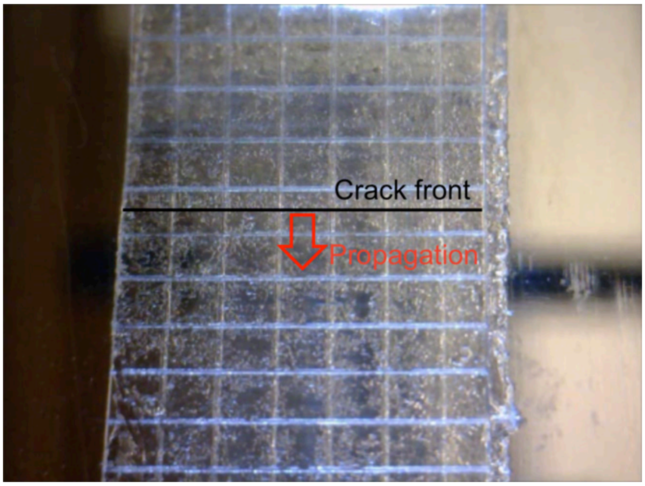


Fig. S4. Assembly of quick-release medical tape. First, the backing (red) was coated with RL (green) and heated to create a continuous nonadhesive surface. Second, areas of the RL were selectively etched to form microscale adhesive regions (parallel lines). Third, the adhesive (blue) was applied either using a transfer film or by heat-assisted evaporation of the solvent cast pressure–sensitive adhesive.



Movie S1. Representative video of 1-mm laser-etched grid lines in a RL-coated PET backing showing crack propagation. The crack front slows within exposed PET regions within laser-etched lines perpendicular to the peel direction and is comparatively fast when traveling across RL-coated regions.

Movie S1