

Table S1. EDS data of the polished internal wall of SS-321 tube with the variation of editronic acid (E) dose in LHC-E chemical polishing formula.

| E wt%_g in LHC-E ^a | Atomic Concentration (At%) ^c | | | | | | | | | | |
|-------------------------------------|---|-------|-------|------|------|------|------|------|------|------|------|
| | Fe | Cr | C | O | Ni | F | Mn | Ti | Si | Al | Mo |
| Nil ^b | 60.03 | 17.71 | 3.25 | 3.90 | 7.98 | 1.84 | 2.33 | 1.52 | 0.47 | 0.37 | 0.59 |
| 0.5%_0.1g | 69.22 | 17.62 | 1.85 | 0.55 | 8.42 | - | 1.75 | 0.85 | - | - | - |
| 1.1%_0.2g | 65.07 | 17.88 | 4.67 | 1.05 | 8.38 | - | 1.43 | 0.43 | 0.53 | - | 0.55 |
| 2.3%_0.4g | 42.67 | 22.67 | 18.96 | 5.69 | 4.61 | - | 1.53 | - | 0.58 | - | - |

^a. The wt%_g is based on the LHC (1/3/9/5 ml); ^b. The crude SS-321 tube; ^c. Sampling from the inner tube wall.

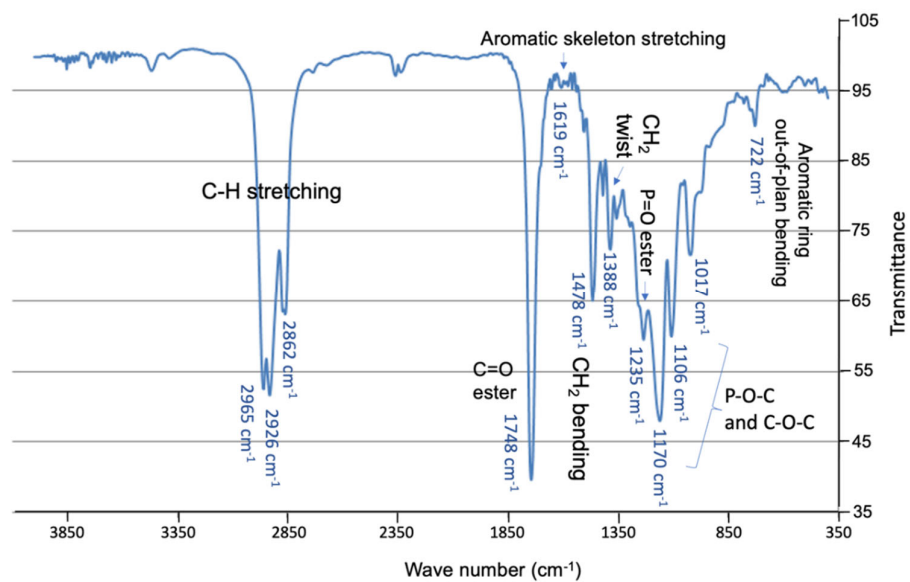


Figure S1. The FT-IR spectrum of the fresh lubricant (Section 2-1), in which the absorption bands are attributed to the respective bond vibration types.

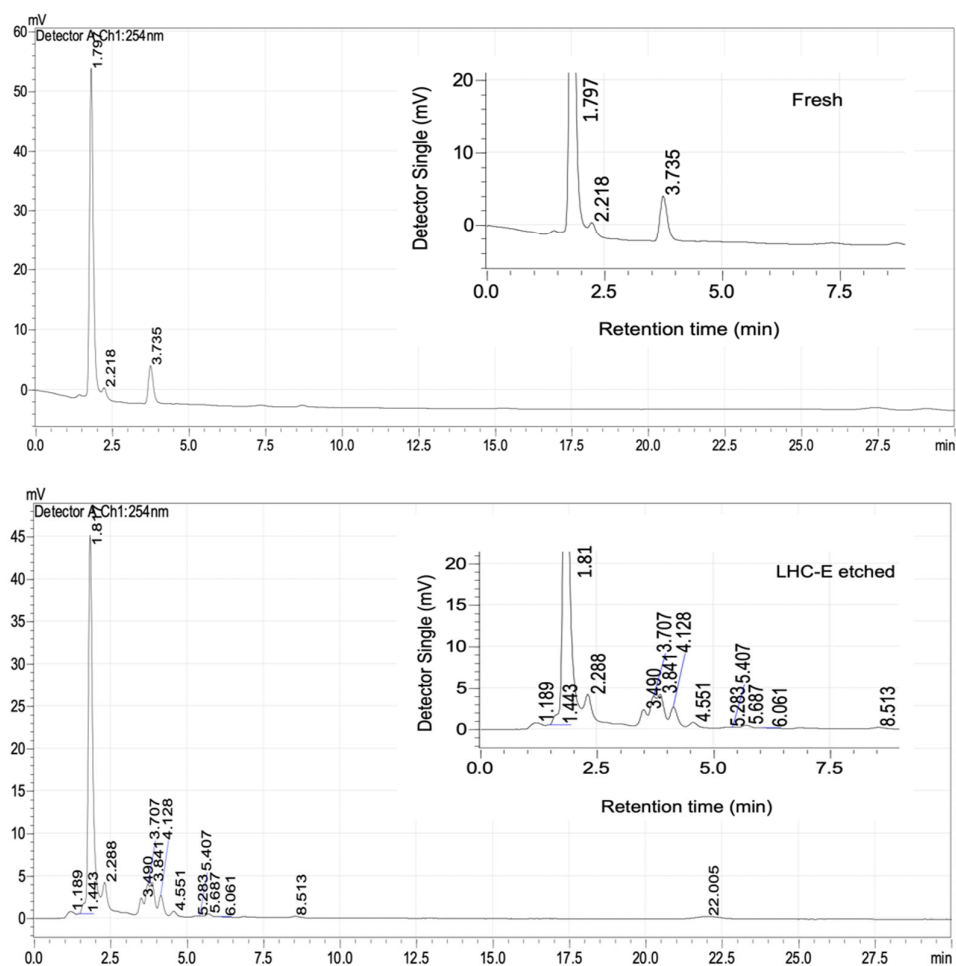


Figure S2. The selected liquid chromatography diagrams of the two samples, where the insets provide the detailed peaks of the main components. The other samples have a similar diagram as sample E4.

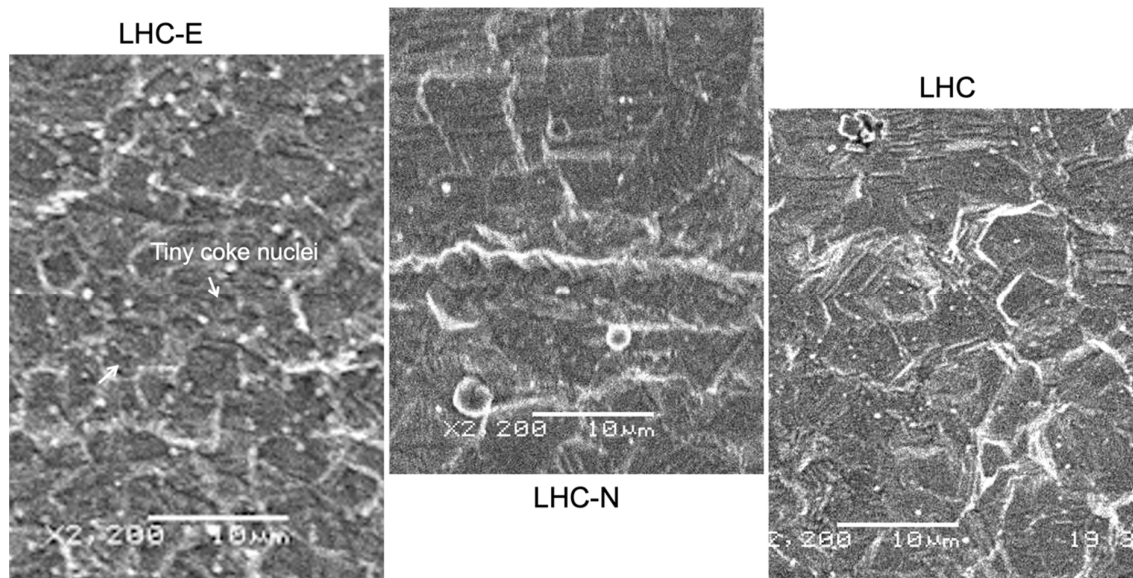


Figure S3. SEM images showing the detailed inner wall surface morphologies of the three tested tubes in question that were tested by heating the sealed lubricant at 300 °C for a course of 56 h. The arrow signs in the left image indicate numerous cokes over spherulites.

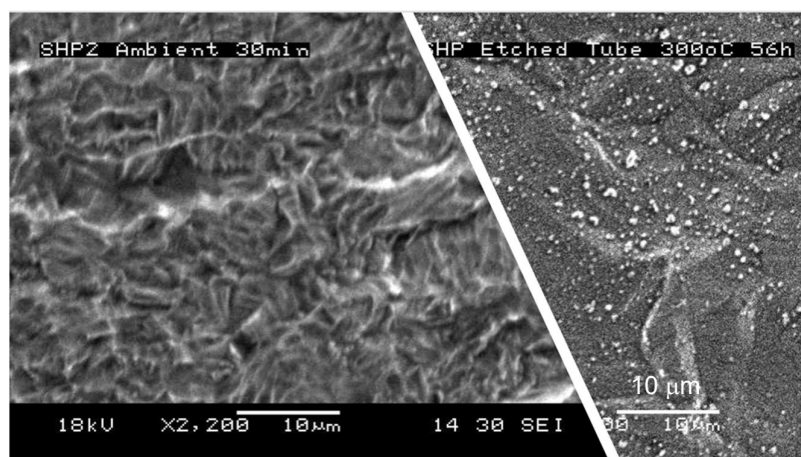


Figure S4. SEM image of the SS-321 tube etched by SHP and that of the tested tube after going through a single oil-heating cycle (56 h) test at 300 °C. .

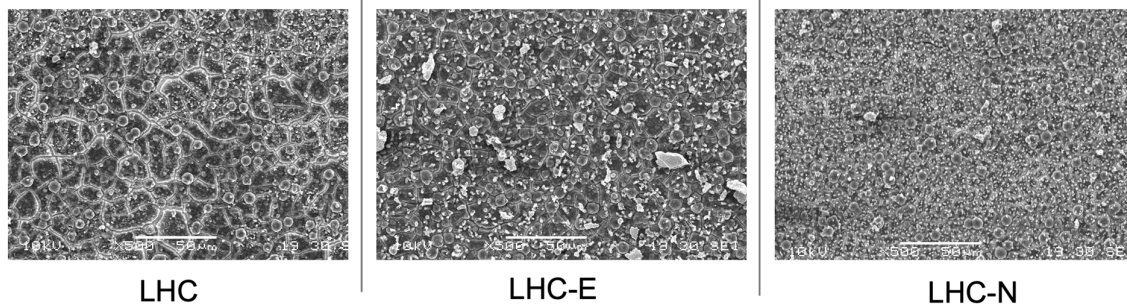
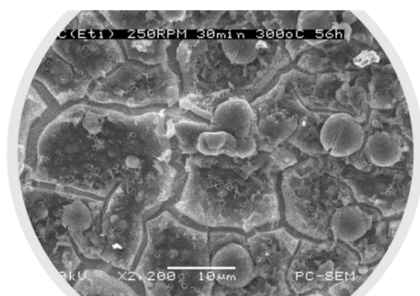
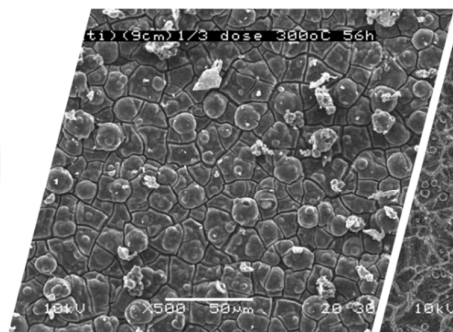


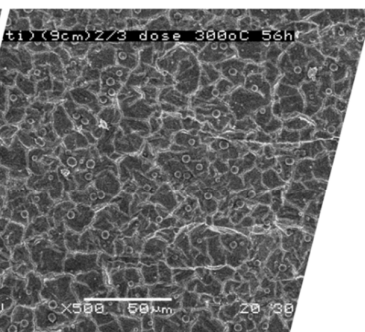
Figure S5. Examination of coking extents occurring inside the three sample tubes prepared by immersing in the same dose of etchant for 240 min. The treated tubes were subjected to a single heating cycle (56 h) at 300 °C before performing the microscopic check. The scale bars are 50 mm in the three SEM images.



LHC-E (250 rpm)



LHC-E (1/3 dose)



LHC-E (2/3 dose)

Figure S6. Leverages of the different etching conditions on the coking extent in the treated tubes. .