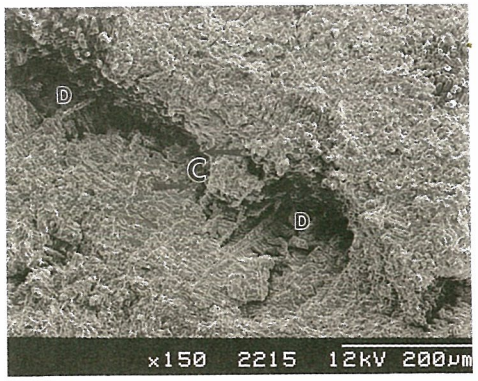

Fig. 8. Crack (C) propagating along the dendritic crystals (D) at the fracture surface.

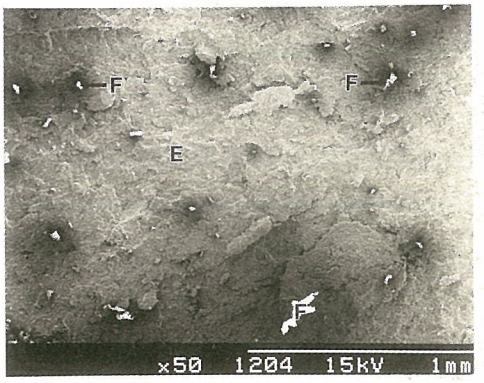

Fig. 9. Surface of a fracture specimen showing a flux inclusion body (F) and equiaxial grains (E) of the parental metal soldered at 1200 °C.

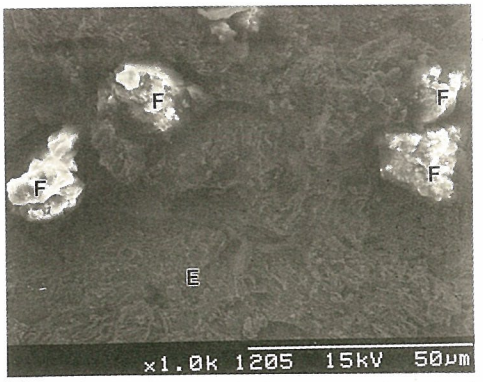

Fig. 10. Decohesion observed for a specimen soldered with pure flux powder at 1200 °C. (E: equiaxial grain; F: flux inclusion body).

continuous-type AE signal observed during nugget formation at the solder junction. The counts and energy values were small for these AE hits, and the maximum amplitude was 46-50 dB. In this period, the frequency for peaks with maximum amplitude in the frequency domain was 117 kHz, and its corresponding amplitude was 1614 units. Subsequent peaks were located near 300-350 kHz and 926-930 kHz, with amplitude values below several hundred units.

In addition, a burst type of acoustic emission signal was observed during the isothermal heating period, which may have been caused by an expulsion of impurities as the sample was heated. The maximum amplitude observed for that type of acoustic activity was about 67 dB, with a count value of 95, and an energy value of 30 units. The frequency of the maximum amplitude was 117 kHz, and its corresponding amplitude was 2.4×10^4 units. The frequency for the second largest amplitude was located at 332 kHz, and its corresponding amplitude was 2.4×10^4 units.

Right after the 18^{th} s, soldering stopped and the specimen began to cool down to room temperature. During the cooling process, high-amplitude AE signals were observed at the 29^{th}, 78^{th}, and 82^{nd} s. The maximum amplitude in AE hits at the 29^{th} s was 74 dB, which was far higher than that observed for hits at different times. For the same hits described above, the count value was 158, and energy value was 80 units. On the other hand, in the frequency domain, the frequency for the maximum amplitude hit was 121 kHz, and its corresponding amplitude was 13.8×10^5 units. The maximum amplitude of the hit collected at the 78^{th} s was 63 dB, with a count value of 80 and an energy value of 31 units. The frequency for the maximum amplitude was 117 kHz, and frequency amplitude was about 2.0×10^5 units. The frequency of the maximum amplitude of AE hits collected at the 88^{th} s was 63 dB, the count value was 136, and energy value was 26 units. The frequency for the maximum amplitude was 313 kHz, and the frequency amplitude was 2.3×10^5 units. Moreover, the frequency for the second largest amplitude was 180 kHz, and its frequency amplitude was 3.9×10^4 units.

Tensile test and SEM examination

The effects of soldering temperature and flux concentration on the UTS using ANOVA showed that flux