ELECTROCHEMICAL ACTIVITIES AT THE CRACK TIP: A LOCALIZED APPROACH

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In this work a localized electrochemical approach, based on scanning electrochemical microscopy (SECM), is used to investigate the electrochemical activities at the crack tip. The SECM measurements are performed by scanning over a surface at a fixed distance of the probe from the surface (d) to capture spatial variation of the current. The SCEM scans are performed in feedback mode at the fatigue crack tip. Figure 1 shows the results of a specimen with a single edge notch made of Stainless Steel 304L that was fatigued to 2×10^5 cycles at nominal stress amplitude of σ_a=75 MPa and stress ratio of R=0. The SECM scans are performed in neighborhoods of the crack tip (scan area of 6mm×1.4mm), as shown in Fig. 1b. We expect that the deformation zone (i.e., plastic zone) ahead of the crack tip would result in different electrochemical activities than zones far from the crack tip and that would provide information about the crack driving force. This is verified by the preliminary SECM results shown in Fig. 1c. For clarity, the color bar ranges from -3.02 to -2.5 nanoamps. The results show a strong spatial variation of the current in neighborhoods of the crack tip (shown by dashed lines in Fig. 1c). The key question to answer in this work is: what information can be extracted about crack driving force from these measurements? We hypothesize that the crack driving force is a sum of mechanical driving force and electrochemical driving force formulated within a Griffith energy framework.

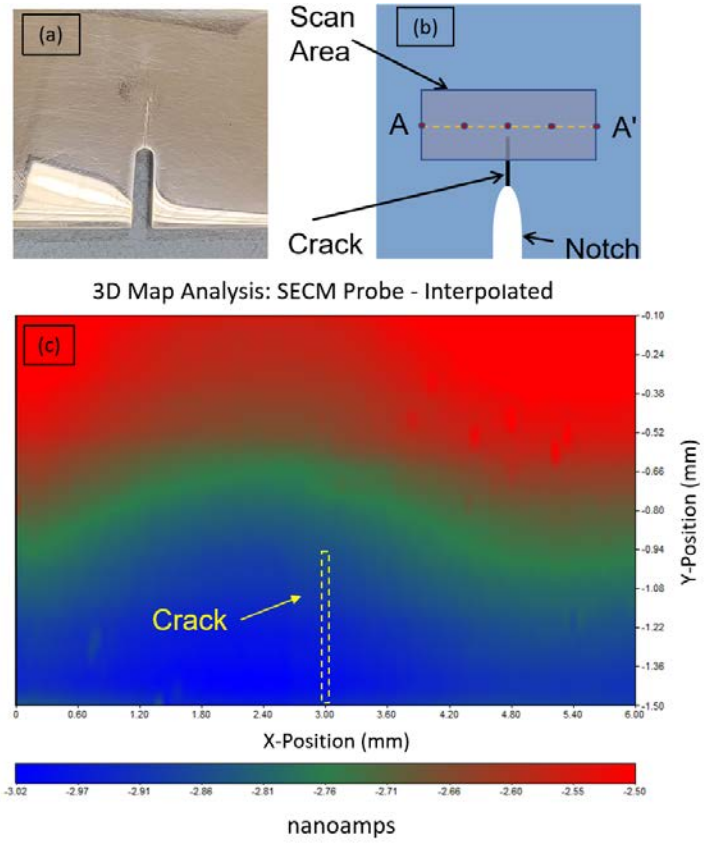

Figure 1: (a) Notched sample with fatigue crack, (b) schematic of analysis area, (c) SECM scan area.