REPRODUCIBLE ACOUSTIC EMISSION SIGNATURES
BY INDENTATION IN STEELS

Roger B. Clough and John A. Simmons
Metallurgy Division
National Bureau of Standards
Washington, D.C. 20234

ABSTRACT

Creating reproducible signals from defects is of great importance for quantitative studies of acoustic emission (AE). A method of doing so is presented here which consists of indentation of hardened steel plates. A survey was made of a variety of steels, including A533B pressure vessel steel with an embrittled weld as well as embrittled W1, O1 and O2 tool steels. Regions in these steels with a Rockwell C hardness greater than about 50 produced detectable AE during indentation. In many cases the signals were reproducible over an appreciable range and appeared to be the same for epicenter measurements as those produced by sudden unloading. However, monitoring on the same surface as the crack in some cases produced sets of two different but reproducible signals which gradually evolved with repeated loading which could be due to crack branching or zigzag motion. Regions in the steels with a hardness less than about 40 on the Rockwell C scale produced no detectable AE, even with appreciable plastic deformation. Examination with scanning electron microscopy indicated that the AE signals were produced by the nucleation and incremental growth of subsurface cracks, generally penny-shaped, less than a millimeter in size. A typical fracture toughness value for such cracks in an embrittled O2 tool steel was calculated to be about 19MNm\(^{-3/2}\). AE was also produced in as-received A533B steel by indentation fatigue. The method suggests itself for materials studies of AE as well as a nondestructive method for in situ examination of structures for embrittlement.
SUMMARY DISCUSSION

William Pardee, Chairman (Rockwell Science Center): I have one quick question. If I were an experimenter with access to the best current hardware electronics, what experiment would you most like to see me do? Which one would be most useful in terms of evolution of the theory? What is the most useful way to take advantage of the theoretical developments?

John Simmons (NBS): Multi-channel source characterization.

William Pardee, Chairman: What frequency range do you think is necessary?

John Simmons: The typical range for that is about between 50 kilohertz and a megahertz.