METRIC

NOTICE OF CHANGE

MIL-HDBK-790
NOTICE 1
30 October 1992

MILITARY HANDBOOK
FRACTOGRAPHY AND CHARACTERIZATION OF FRACTURE ORIGINS IN ADVANCED STRUCTURAL CERAMICS

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1. THE FOLLOWING PAGES OF MIL-HDBK-790 HAVE BEEN REVISED AND SUPERSEDE THE PAGES LISTED:

NEW PAGE	DATE	SUPERSEDED PAGE	DATE
21	29 October 1992	21	1 July 1992
22	29 October 1992	22	1 July 1992

2. RETAIN THIS NOTICE AND INSERT BEFORE TABLE OF CONTENTS.

3. Holders of MIL-HDBK-790 will verify that page changes and additions indicated above have been entered. This notice page will be retained as a check sheet. This issuance, together with appended pages, is a separate publication. Each notice is to be retained by stocking points until the military handbook is completely revised or canceled.

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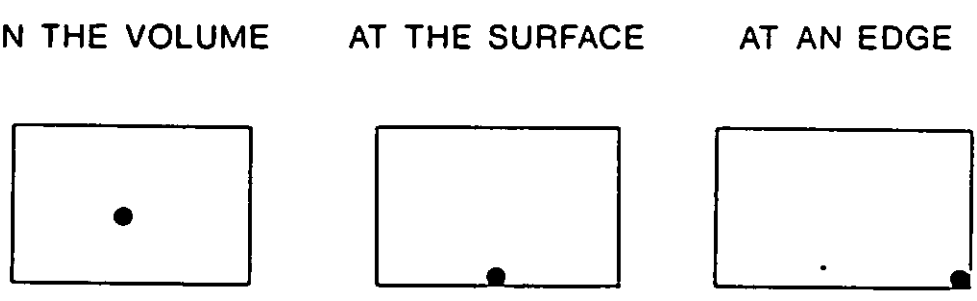

FIGURE 17. Schematic showing how a volume-distributed flaw can be located in the volume, at the surface or at an edge.

2.2.2 Flaw Characterization - IDENTITY.

(a) Flaws will be characterized by a phenomenological approach which identifies what the flaw is and not how it appears under a particular mode of viewing. Descriptions of the mode of viewing may be used as qualifiers, i.e. "pores that appear white when viewed optically", but use of the appearance, i.e., "white spots" should be avoided. (This approach is chosen since flaws appear drastically different in optical versus electron microscopy.)

(b) Section 3 gives a nomenclature which is applicable to many advanced ceramics. It must be recognized that not all flaws can be so characterized and that many flaws are specific to a material and its process history. The nomenclature is designed to identify the flaw by name (e.g. pore, inclusion) and is separated based on the inherent spatial distribution of the flaw in the bulk ceramic. Flaws can also exist coincidentally, in which case some judgment is required as to which flaw is dominant or intrinsic. Flaws can also be described by paired expressions, e.g., a pore/large grain.

NOTE: Flaws can sometimes be difficult to characterize if they have mixed attributes. For example, porous regions often have pores associated with them.

2.2.3 Flaw Characterization - LOCATION.

(a) The location of the flaw in a given specimen shall be qualitatively determined. The flaw must be characterized as being located in the bulk (volume), at the surface, near the surface or at the edge (if such exists) e.g., a volume-distributed pore, located at the surface.

NOTE: The flaw location (which specifies only the location of the strength-limiting flaw in a given specimen) shall not be used to

statistically differentiate flaw populations!

(b) In some instances, it is useful to specify further the flaw location if it is near the surface, but not in direct contact. This location category is be termed near surface (NS). This additional specification of location is important for fracture mechanics evaluation of flaws and service-performance issues but not to differentiate the inherent flaw population. For example, some near-surface flaws may be more susceptible to time-dependent crack growth than equivalent flaws in the bulk. Near surface flaws may also be likely to link up with surface machining and/or impact damage or to extend subcritically to the surface prior to catastrophic fracture. Due to the difficulty in defining "near surface" and because this location category may only be applicable to design (Table I, Level 3) it is suggested that the analyst consult the design engineer for a definition before continuing with SEM fractography. The criteria, with supporting reasoning, shall be included in the report section. The proximity to the surface shall be noted by estimating the perpendicular distance from the surface to the closest point of the flaw.

2.2.4 Flaw Characterization - SIZE (optional).

(a) Flaw size characterization is only required by this MIL HBK in a qualitative sense as necessary to identify the general nature of flaws (i.e., the 20 μm pore versus the 1 μm porosity). For equiaxed flaws the mean diameter shall be reported and for nonequiaxed flaws the major and minor axis shall be reported.

NOTE: Precise flaw measurements are usually not helpful since the flaws' true size may not be revealed on the fracture surface, and fracture mechanics analyses of most flaws are not possible due to their complex shape. (An important exception is machining damage wherein flaw size measurements may be very useful for estimates of fracture toughness).

2.3 Report.

2.3.1 General. A sample reporting format is shown in Figure 18. The report shall contain the following:

a. Fractographer's identity;
b. Equipment used;
c. Overall flaw types identified;
d. The Flaw Identity, Location, Size (optional) and the mode of viewing (optical vs SEM) for each specimen.
e. The inspection criteria (e.g., as per Table 1);
f. Supplemental observations such as transgranular or intergranular fracture (or the approximate ratio of each) are highly encouraged.

2.3.2 To the extent possible, couple the fractographic observations directly to process history and resultant microstructure. Representative micrographs of polished sections of the microstructure showing porosity and grain size distribution are highly recommended.

2.3.3 Couple the fractographic observations directly to the mechanical test results. Fractographic montages and labeled Weibull or other strength graphs (figures 19-21) are an exceptionally versatile means of accomplishing this. Montages present the fractographic results in a comprehensive manner.