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IT-5-P-1986 Advantages of FEG-EPMA for Microphase Analysis in Nuclear Materials

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Many nuclear materials include micrometer-scale particles or phases that require characterization to understand and improve material fabrication techniques and processes. The microphase inclusions can be characterized with better precision thanks to the new generations of Field Emission Gun Electron Probe MicroAnalyzers (FEG-EPMA) whose high-resolution electron beam operating at low voltage optimizes and reduce electron interaction volume [1] [2].

An example of characterization is presented in relation with a study of the crystallization of certain phases in a glass matrix used for nuclear waste applications. Depending on the glass composition and the melting and cooling conditions, crystals can form in the matrix. The characterization of these phases, often of micrometer size, and of the glass including them are primordial in basic studies to elucidate the mechanisms involved. The composition of the including glass can be characterized by means of a CAMECA SX 100 electron microprobe with a low-resolution electron beam. On the other hand, the microcrystals studied here, apatite containing rare earth elements and microparticles of platinum-group metals, require the use of FEG-EPMA to determine their chemical composition because of their small dimensions (less than 10 µm: Figure 1). The analyses were carried out with the CAMECA SX 100 and SXFiveFE at 12 keV and 10 nA. The improved analytical resolution obtained with the CAMECA SXFiveFE made it possible to optimize the analysis of the micro particles, and to determine their chemical formulas.

A second example of characterization is presented in the context of coating materials used in nuclear processes. The coatings must have satisfactory homogeneity to ensure material adhesion and sealing. Any chemical homogeneity defects must then be characterized in order to optimize the manufacturing process. In this context a sealing material containing impurities in the form of micrometer-scale layered inclusions was characterized by EPMA (Figure 2). The analyses were carried out with a CAMECA SX 100 and CAMECA SXFiveFE at 15 keV and 10 nA. A comparison of the results shows the optimization obtained with the CAMECA SXFiveFE due to the high resolution of the electron beam.

REFERENCES

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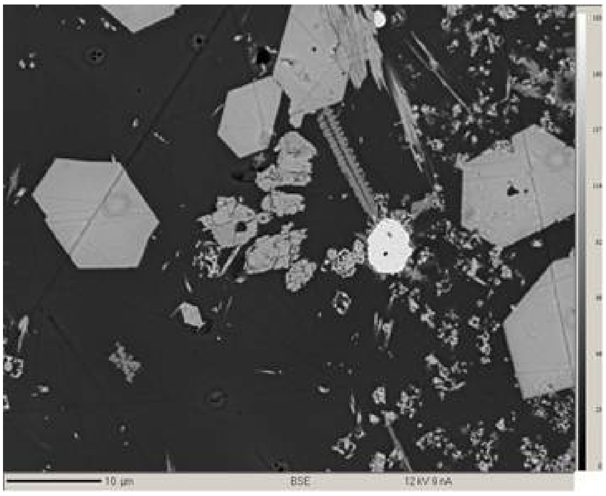

Fig. 1: Microparticles in a nuclear glass matrix

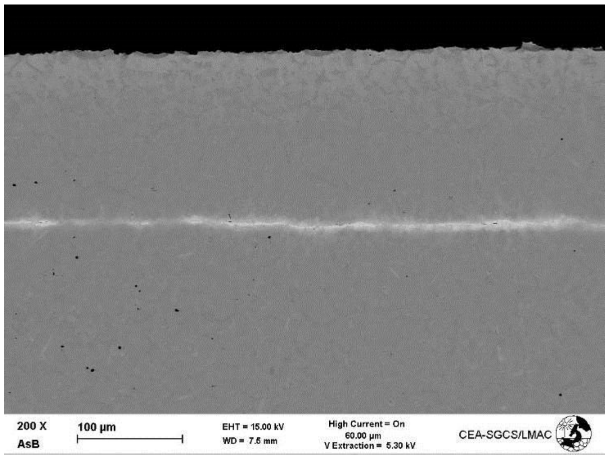

Fig. 2: Stratified material with a thin vein