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Extinction Characteristics of Six Tremolites with Differing Morphologies

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KEYWORDS

Tremolite, amphibole, fibrous, morphology, extinction angle.

ABSTRACT

There has been considerable discussion in the literature related to the use of standard optical properties of commercial asbestos minerals for the classification of amphibole minerals found in raw materials as either asbestiform or as non-asbestos (1-4). The goal of this study was to ascertain if there is a relationship between particle morphology and extinction characteristics in monoclinic tremolite amphiboles. Six tremolitic amphiboles were chosen for this study: three are fibrous(five from natural sites (i.e., mining locales)) and one is the NIST SRM 1867a tremolite standard. The morphology of these tremolites ranged from blocky to asbestiform. A particle-by-particle analysis was performed to determine extinction characteristics and the number of EPA-defined asbestos characteristics. In general, zero or near-zero extinction angles correlate to the number of asbestiform characteristics. Exceptions to this occur when a non-fibrous tremolite has (100) parting as a result of twinning or when fibrous tremolites are elongated in the a-crystallographic direction, therefore preferentially lying on (010). However, when using extinction characteristics in conjunction with morphology, the differences between habit is discernable. The three fibrous tremolites have different fiber widths and, as such, exhibit different extinction characteristics. The smaller the diameter of the fibers, the greater number of particles exhibiting parallel extinction. The sample with the smallest widths (< 0.5 μm) displayed parallel extinction for all particles. When fiber diameters are small (<1 μm) optically visible fibers are in fact bundles of fibrils and are not single crystals; they therefore show parallel extinction.

INTRODUCTION

The asbestiform habit is a unique mineral growth characteristic in which minerals form as bundles of randomly oriented ultra-fine fibrils weakly bound together. The individual fibril surfaces develop during crystallization and are not a result of fracture, cleavage or parting. The fibrillar structure of optically biaxial asbestiform minerals (i.e., the amphiboles) results in uniaxial-like properties, when examined using polarizing light microscopy (PLM) (1). As a result, asbestiform bundles of monoclinic amphiboles of sufficient dimension to be visible in the PLM, have parallel or near parallel extinction. In addition to defining the optical properties of asbestiform bundles, the unique growth mechanism of the asbestiform habit is fundamentally responsible for the widely recognized properties of asbestos: namely flexibility and tensile strength. These same characteristics are also generally accepted as the underlying reason for the adverse health effects of commercial amphibole asbestos fibers (2,3). The long, thin, readily separable fibrils can penetrate and lodge in the air exchange portion of the lung where they ultimately provoke disease. In natural ore or rock, asbestos fibers form in parallel or radiating bundles generally occurring in veins. They generally have a smooth silky fibrous appearance and can be teased into matted balls or bundles when lightly abraded.

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