INTERFERENCE TECHNIQUES AND THEIR APPLICATION IN CEMENT MICROSCOPY

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ABSTRACT

Polished cross-sectional surfaces of Portland cement and clinker are routinely examined using normal-incidence reflected light optical microscopy. Use of a chemical etch imparts variation in color and texture among and within the various crystal phases which are readily realized using normal-incidence reflected light. Interference techniques have shown utility for examining subtle variations in surface topography in other fields. The intent of the present article is to introduce a particular optical inference technique, Nomarski Differential Interference Contrast Microscopy, and to illustrate through examples the potential usefulness of this technique for examining chemically etched, polished surfaces of cement and clinker materials.

INTRODUCTION

Optical microscopy has proven its usefulness as an analytical tool for the quality control of cement processing. The cement chemist can readily observe and distinguish the various phases in a Portland cement or clinker by the use of various chemical etches. The principles of operation are well understood and fairly straightforward (1,2). Polychromatic parallel illumination from a Tungsten source impinges on a polished cross-sectional sample surface. This light is then reflected back by the sample surface through an objective and viewed through an eyepiece or captured on photographic film. Polarizing films may be placed in the light path in order to achieve a plane-polarized light source, which may be used to help identify various phases in a sample by their isotropic/anisotropic optical behavior.

The contrast in a normal-incidence, reflected light image is derived mainly from preferential absorption and scattering of the impinging light. In a material that contains several different phases, such as Portland cement, both differences in refractive index and absorption lead to contrast differences in the optical image. For chemically etched surfaces, differences in contrast are also brought about by the scattering of light.

While scattering events brought about by the observation of a chemically etched surface are apparent using normal-incidence, reflected light, surface topographies can be better realized using Nomarski Differential Interference Contrast (3). Nomarski interference is an application that uses a split light source in order to amplify the effect of small height differences on the sample surface. The principle of operation is as follows. Polychromatic illumination from a tungsten source is plane-polarized using a polarizing film. The beam is then split using a Nomarski prism into two beams that impinge on the sample surface, as shown in Figure 1. If there is a small height difference between the two points where the beams hit, a phase difference results between the two beams. The two beams are reflected and again passed through the