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HYDROGARNET-TYPE CUBIC CRYSTALS IN POLYMER-MODIFIED MORTARS

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ABSTRACT

Polymer-modified mortars (PMMs) using recently developed redispersible polymer powders and aqueous polymer dispersions have become popular construction materials in the world, particularly for finishing and repairing works, because of their excellent performance and durability. In order to develop usable models of structure-property relationships for such systems, the authors have focussed their studies on the microscopic level because such aspects still need more information. In this context, they have already reported their detailed observations on the formation of $Ca(OH)_2$, AFt, AFm, hollow tubules, and hollow crystals in PMMs (1–5). However, studies on hydrogarnet-type cubic crystals in PMMs were not available by that time.

The purpose of this paper is to establish morphologically the formation of hydrogarnet-type cubic crystals in PMMs. © *1997 Elsevier Science Ltd*

Introduction

Hydrogarnet-type cubic crystals may be the final hydration product of tricalcium aluminate (C_3A) phase. Such crystals are a less soluble and more stable hydrate of the composition C_3AH_6 and are formed directly at room temperatures in pastes with a low water-solid ratio. Under such conditions, owing to considerable heat evolution, the temperature of the paste rises further, favouring the formation of C_3AH_6. In cement, cubic C_3AH_6 may convert to hydrogarnet by taking up silica (6).

The study of calcium aluminate hydration products in cementitious systems is particularly important in the development of microstructure in certain types of cements like expansive cement. Moreover, they are of major concern in the sulphate attack and perhaps in other secondary degradation processes (7). It was suggested that sulphate resistance of cements, which were subjected to a steam treatment, may be due to the formation of unreactive

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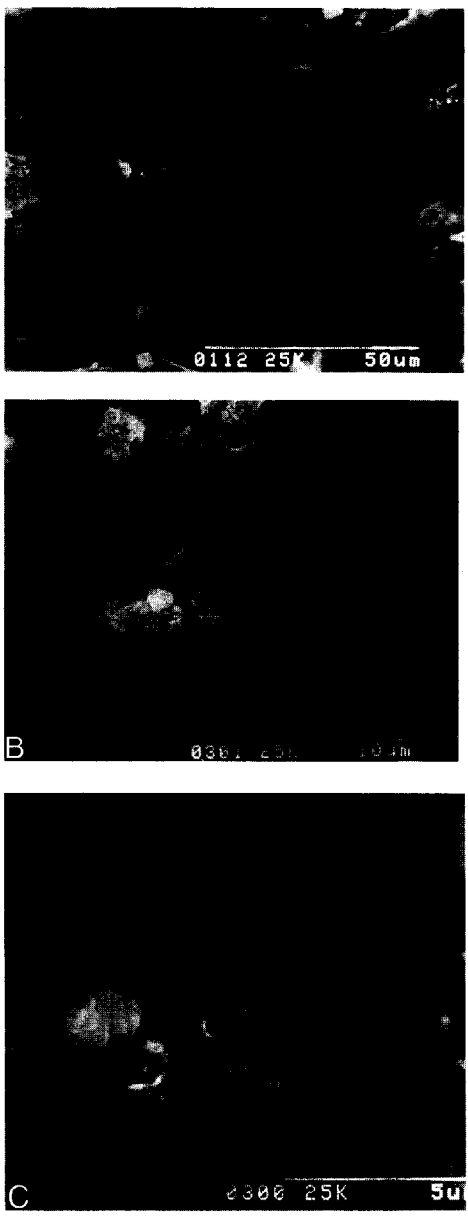

FIG. 1.
Hydrogarnet-type cubic crystals at various magnifications in SBR-modified mortars with a P/C of 5%: (*a*) low magnification micrograph, (*b*) higher magnification micrograph, (*c*) further increased magnification showing greater details.

hydrogarnets from C_3AH_6 (8). Sometimes, the strength of the material was also attributed to the formation of a closely welded network of the cubic phase (9).

For the morphological characterization of hydrogarnet-type cubic crystals, PMMs with 25 mix proportions using six commercial cement modifiers, including both redispersible

polymer powders and aqueous polymer dispersions, were prepared with various polymer-cement ratios (P/C) and cured. The fractured surfaces of such PMMs were then observed by by a scanning electron microscope. The details of materials, mix proportions, and testing procedures were the same as those mentioned in Reference 2, except that the curing period of the mortar specimens was reduced from 28 to 7 days. The reasons and details of this variation have been mentioned elsewhere (3,4).

According to the present studies, hydrogarnet-type cubic crystals, closely resembling to those shown in reference (10), are observed in SBR-modified mortars with a P/C of 5% as shown in Figure 1. At lower magnification (Fig. 1a), hydrogarnet-type cubic crystals, having clear resemblance to sugar cubes, are seen scattered through the mass of the specimen. Such crystals appear very smooth on this lower magnification level. However, on higher magnifications (Figs. 1b and c), the appearance of the same crystals does not remain so smooth and becomes slightly rough. The presence of hydrogarnet-type cubic crystals in the above SBR-modified mortars is justified in opposition to unmodified mortars, where such crystals are not observed under present conditions, because the above-mentioned PMMs have lower water-cement ratio than the unmodified mortars (2), which favours the formation of hydrogarnet-type cubic crystals (6). Conversely, the presence of hydrogarnet-type cubic crystals in some PMMs and their absence in certain other PMMs makes it obvious that the formation of such crystals in PMMs depends upon the type of cement modifier used and the P/C or both. This happens because microstructure-forming process respond to all aspects of internal environment during hydration (7). Because each cement modifier has different characteristics, it can enter into chemical responses with the developing hydration system differently (5), hence, affecting the formation of hydrogarnet-type cubic crystals up to different extents in various PMMs.

In conclusion, hydrogarnet-type cubic crystals are observed in PMMs. However, their formation depends upon the type of cement modifier used and P/C or both.

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