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Solvent Effect on the Morphology of the Bee – Structure Observed by AFM on Bitumen Sample

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Abstract – This work characterized asphaltic cement (CAP30/45) comparing to AFM morphology and composition. It is correlated with "bee" structure visible on this film. The morphology in CAP30/45 , toluene, heptane films was studied by AFM tapping mode showed typical "bee" structure in asphaltic cement films, but this structure is not visible on the other films. Toluene is able to dissolve asphaltene fractions of bitumen and heptane is a totally non-polar solvent that dissolves maltene fractions. Bitumen, toluene and heptane films AFM image was taken by the phase mode, height mode and it was presented in a 3D perspective view and was done map adhesion forces with the AFM.

The objective of this work is to characterize the asphaltic cement penetration grade 30/45 (CAP 30/45) based on the morphology of the "bee" structure observed.

Bitumen is composed of two principles fractions: asphaltenes and maltenes. The dissolution of bitumen in a solvent has a large effect on its structure. Toluene is a solvent able to dissolve the asphaltene fraction. The maltene phase of bitumen is a mixture of different types of hydrocarbons, ranging from paraffinic species. It remains when the asphaltenes are removed and constitute the fraction of asphalt which is soluble in n-alkane solvent such as heptane.

Researchers have been studying the morphology of asphalt binders, some of them have believed that the dispersed phase, with a "bee-like" appearance is attributed to asphaltenes. In this respect, the extent of bee structure was found to correlate with the asphaltene and maltene fractions contents in bitumen, which would to a direct relationship between the bee and the asphaltenes.

The first step to sample preparation: CAP 30/45 was heated at about 165ºC. Sample was melted and then spin casted on glass. For atomic force microscopy (AFM), these films were then cooled to room temperature and humidity safe for 24 h before imaging. To prepare the toluene films, CAP samples were spikes with 200 μL of toluene(HPLC). The same procedure is used to obtain heptane films. For AFM these films have been dried to room temperature and were then left at 50% relative humidity.

Structural characterization of the samples was carried by means on AFM. All images were acquired in tapping mode at room temperature. One dominant structure is in the form of bee, called "bee structure", appeared only in CAP films. Our observation can are agreement with the Masson at al.[1] model were the multiphase bitumen consist of "bee" structure , dispersed phase or the matrix referred as the *catana* or *catanic* phase.

Also bitumen, toluene and heptane films AFM image was taken by the phase mode, height mode and it was presented in a 3D perspective view and mapping adhesion forces with the AFM. The catana phase was observed in CAP films investigated, but wasn't observed in toluene films, where it was impossible to observe depression and protusions. In heptane films it was possible to observe only protrusions. AFM images show that the bee structure possible originates from a super complex structure containing asphaltene.

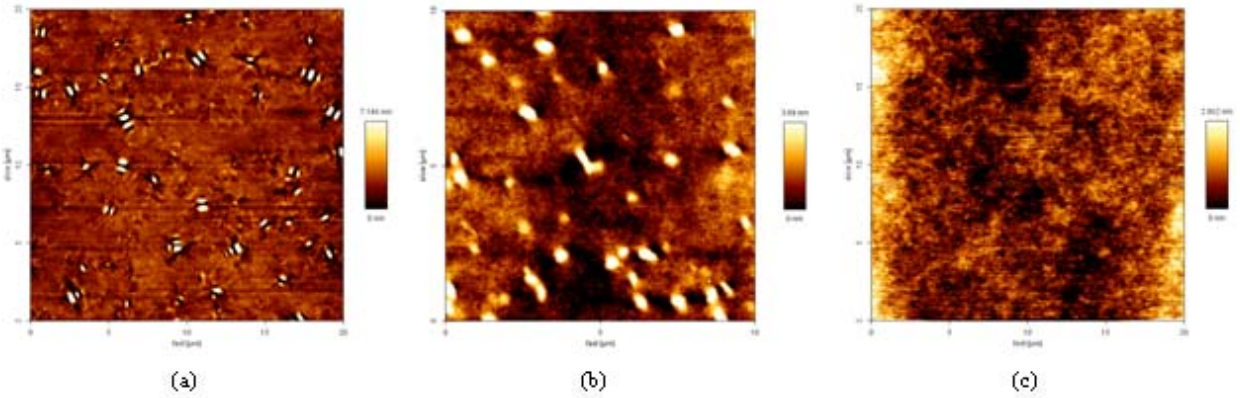

Figure 1- a) CAP 3045 height mode b) Heptane film height mode c) Toluene film height mode

[1]Masson, J.F., Leblond V., Margeson J. "Bitumen morphologies by phase-detection atomic force microscopy".Institute for Research in Construction, National Research Council Canada, Ottawa, Ontario, Canada, 2005.