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THE INFLUENCE OF THE PITCH BINDER CONTENT ON THE STRUCTURES AND PROPERTIES OF MOLDED GRAPHITES PREPARED WITH VARIOUS FILLERS*

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ABSTRACT

A series of molded compacts were prepared by a standardized molding procedure in which the pitch content in the green mix was varied. The compacts were prepared with pitch binder levels of 0, 15, and 25 wt-% and fillers of uncalcined needle-coke, calcined needle-coke, or natural flake graphite. The carbonization and graphitization of the binder-filler artifacts were studied by micrographic examinations, by monitoring the volume and weight changes during heating, and by the measurement of selected physical properties. Thermal expansion coefficients, orientation factors, electrical resistivity, modulus of rupture, density, pore volumes, apparent crystallite height, and lattice parameters were measured on samples heated to 2600°C.

Large volume shrinkages of about 30% were observed during carbonization and graphitization of compacts which were prepared with uncalcined coke. These large volume changes were accompanied by a large decrease in electrical resistivity of all compacts and a large increase in the strength of the compacts which contained pitch binder carbon. There were no strong intergranular bonds formed in the absence of a pitch binder. In the compacts which were prepared with a natural flake graphite filler, no strong intergranular bonds were attained.

During baking the carbonization of the pitch binder occurred external to the uncalcined coke filler particles and predominantly in locations between the filler particles. During baking of these compacts the filler particles also carbonized further and thus the filler and binder carbons shrunk irreversibly. This action produced strong intergranular bonds. In the case where calcined coke was used as a filler, the pitch binder was soaked up by the porous filler particles prior to baking, probably during mixing, and a large portion of the binder carbonized within the pores of the filler particles. These compacts were relatively weak and fragile.

A series of experiments were performed in which the baking and thus the carbonization of the binder was done in small increments in the range 500° to 900°C. In these samples the binder portion of the compacts prepared with uncalcined needle-coke particles could be distinguished from the filler grains by micrographic methods during the early stages of baking, i.e., up to about 700°C. Thereafter, the two components blended to one microstructure. The binder portion of compacts prepared with calcined coke could not be observed unambiguously by micrographic techniques at 500°C or above.

The addition of pitch binder in the green mix altered the microstructure and the pore volumes and consequently the properties of the compacts which had been heat treated to 2600°C. By increasing the pitch content in the green mix, the total pore volume was reduced, but the closed pore volume was increased. These alterations in structure produced attendant changes in the anisotropy of the compacts; higher pitch contents in the green mix produced a more isotropic material (see Figure).

The data will be discussed in terms of the changes in microstructure of the binder-filler artifacts as they are influenced by the addition and carbonization of a second carbon component in the presence of the various fillers. The crystalline state of the binder component will be discussed.

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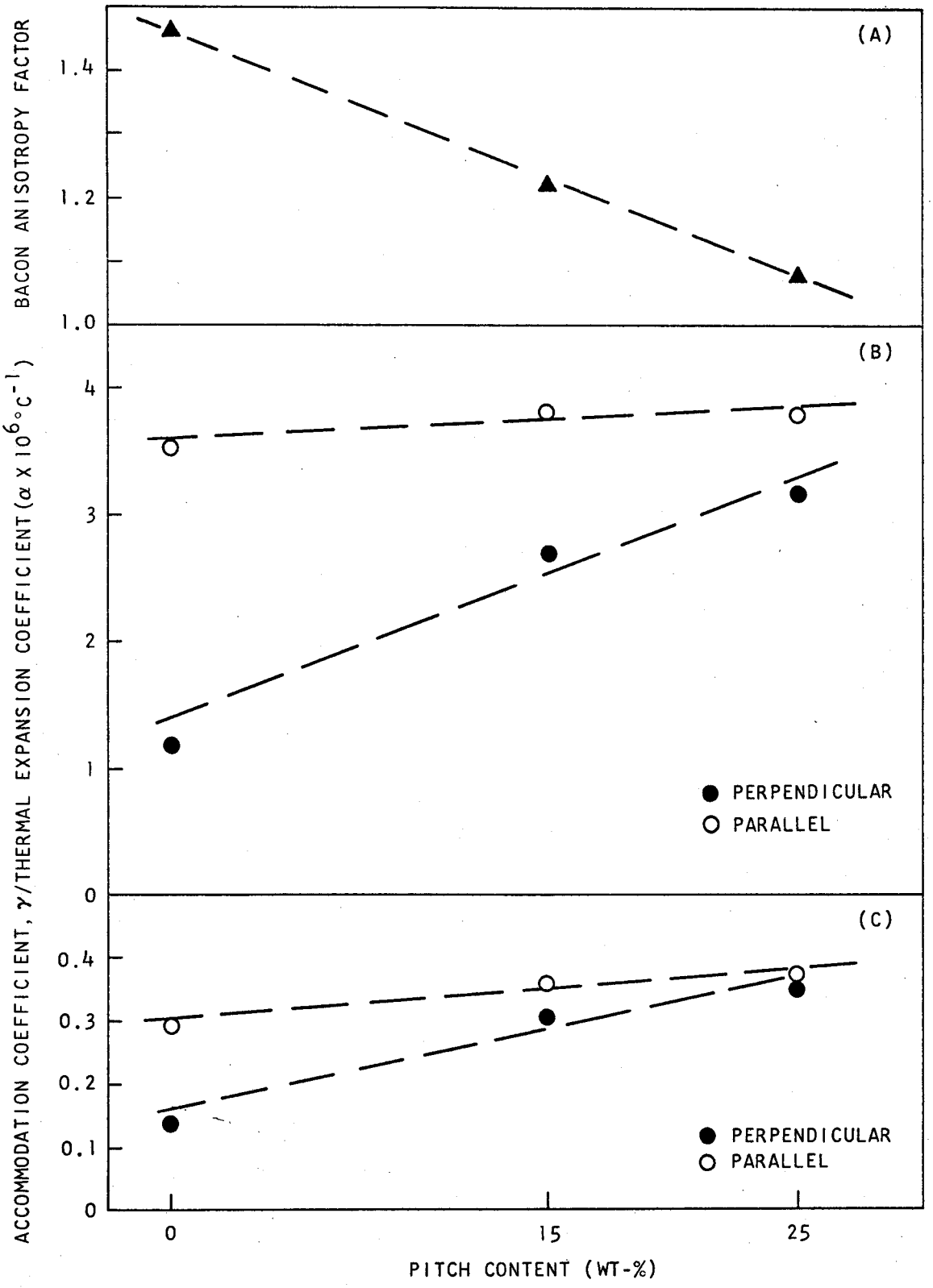

Figure Effect of pitch content in uncalcined needle coke bodies heat-treated to 2600°C on (a) Bacon anisotropy factor, (b) thermal expansivity, α, and (c) accommodation coefficient, γ, for thermal expansion.