Metallurgical coke is a key material for blast furnace operation, acting as [Andriopoulos et al., 2003]: an energy source (fuel), a carburisation agent, a reductant, and a structural support. It made of several blends of coal by heating their mix in coke batteries up to 1200°C. Carbonization of coals during the coking process leads to the development of various microscopic textures, which have an influence on chemical and physical properties of the resulting metallurgical coke. The textures of a coke are usually characterized on the basis of their optical behaviour in polarized light. There are three dominating textures [Hideo et al., 1983]: highly oriented banded, mosaic and isotropic.

The effect of addition of high density polyethylene (HDPE) to the textural features of experimental metallurgical coke has been studied using polarized light optical microscopy and wavelet-based image analysis. The samples were made in a laboratory-scale furnace without (100 % coal) and with 2.5, 5.0, 7.5, 10.0 and 12.5 % of HDPE and polished in rounded sections. Optical investigations were done with Olympus BX51 optical microscope equipped with digital camera. Special software [Mattila & Salmi, 2008] developed in MATLAB with its Wavelet Toolbox was used to perform image analysis. According to Makkonen et al. [2009], any given sample of coke can be representatively characterized with wavelet-based image analysis by studying 7-11 points. At every point, 4 images under different positions (20°, -20°, 0°, 90°) of polarizing lenses should be taken. The program divides (Fig. 1B) the images (2048x1536 pix) into 12 sub-areas (512x512 pix) and calculates each sub-area separately. As a result, it gives the amount (%) of isotropic, mosaic and banded textures, as well as pores. In this study, each sample was photographed and analysed in 10 areas (Fig. 1A), which gave 120 sub-areas for the image analysis and 120 datasets per sample for subsequent statistical calculations.

Optical observations of the samples have shown that there are some differences in textural features of cokes prepared with and without HDPE. In the samples containing HDPE, relatively large pores with rounded shapes and smooth outlines (Fig. 2C), which sometimes cover entire area of the image, can be observed more often than in the coke prepared without HDPE. In some cases, the pores in HDPE-containing coke have an almost ideal spherical shape. The calculations have found that the addition of HDPE results in a decrease of mosaic texture and some increase of isotropic texture. Ethylene, formed from the decomposition of HDPE, was considered as a probable gas affecting the texture adjustments. The approach used in this study can be applied to indirect evaluation of reactivity and strength of metallurgical coke.

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Fig. 1: Polished section with locations of the points (A) and a map of sub-areas for the image analysis (B).

Fig. 2: Wavelet-based image analysis of experimental metallurgical coke. A,B - 100% coal, C,D - 87.5% coal and 12.5% HDPE. Scale bar - 50 µm. Textures: isotropic - green, mosaic - red, banded - yellow, pores - blue.