According to SEM microanalysis, the hexagonal wafers are nearly pure Cr_2O_3, and the octahedral crystals are mainly spinels based on (Mn, Cr)(Cr, Mn)$_2O_4$. The uniform layer of such octahedral crystals is also typical for ITM14, ZMG232 and Crofer 22APU steels. Crofer 22APU and ITM14 also have some large octahedral crystals on the surface (Fig. 3).

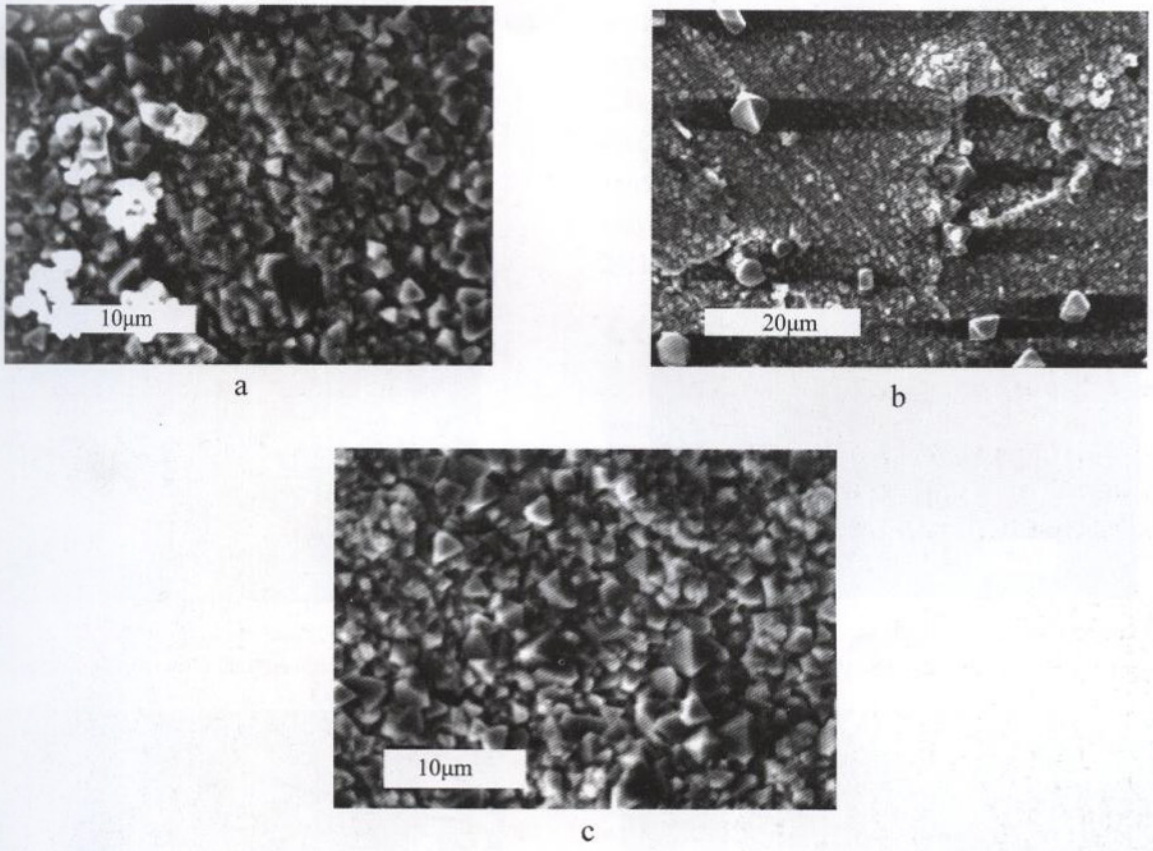

Fig. 3. Surface morphology of steel Crofer 22APU (a), ITM14 (b) and ZMG232 (c) after oxidation in air (800°C, 170 h).

Observation of the oxide surfaces at higher temperatures shows significant differences between them. At higher temperatures the scale surface became more homogeneous, and the spinel phase disappears on AISI 430 and ITM14 specimens (Fig. 4).

For 430 steel at 900°C a specific surface profile with oxide "pinches" growing in different directions can be seen but at 1000°C surface became smoother. The microanalysis of samples confirms oxides as Fe_3O_4 and Me_2O_3 but no spinel was found here.

Crofer 22APU and ZMG232 steels show other tendency. There are spinel phases formed at all temperatures studied (800, 900, 1000°C). At higher temperatures significant growth of octahedral crystals was observed (Fig. 5).

SEM examination has revealed small and large octahedral crystals which have different appearance vs. oxidation conditions. They have been identified as spinels based on $MnCr_2O_4$, (Mn, Cr)(Cr, Mn)$_2O_4$ and $(Cr_{1,3}Mn_{1,3}Fe_{0,4})O_4$. Small crystals are the most probably mixed oxide (Cr, Mn)$_2O_3$ (Table 2).

Table 2

Surface composition as analysed by SEM/EDX (Sp – spinel, Ox – oxide).

Steel	800°C	900°C	1000°C
430	Sp	Ox	Ox
ITM14	Sp, Ox	Ox	Ox
ZMG	Sp	Sp	Sp
Crofer 22APU	Sp, Ox	Sp	Sp, Ox

These spinels and mixed oxides have distinctly