Ceramics, Oxides, Geomaterials

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Characterization of partial smelting in earthenware ceramics through high resolution microscopy methods

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Sintering is a well known terms in the ceramic science. Ceramic materials are the objects which must be sintered for getting their better physico-chemical properties, and consequently proved to be in thermodynamically meta-stable condition. Sintering has mostly been investigated as a mechanism not a result. Sinter temperature is the temperature by means of this the grain boundaries have to be damaged in order to build a smelt. Archaeological earthenware objects among them are interesting objects which consist of different mineralogical phase constituents and also different sinter temperature due to the kiln construction in the antiquity. Characterization of sinter structure helps also archaeologist for better understanding about the technology in the past. Indeed, ceramic technology is the oldest human tradition, but the newest scientific knowledge and therefore investigation on old objects can obtain better interpretation for characterization of technical ceramic's manufacturing process nowadays [1]. Sintering is not a process that quickly happened; rather it took place via partial smelting of the grain boundaries in the matrix [2]. According to this point of view, sintering and partial smelting of the matrix must study together, consequently. Sintering is discussed here as result and partial smelting as the process. In many cases we talk about good firing and sintering whereas the heat transfer process was not carried out completely. According to the crystalline phase composition and their decomposition, it will be noticeable for us to explain the state of the objects as in partial smelting zone or smelting zone. Investigation regarding to the partial smelting state is considerable because in this state the matrix is exposed to maximum mass diffusion through the crystalline phase decomposition [3]. Different samples have studied by means of their application for characterization of sintered texture. The samples are prepared as thin section and observed by polarization light microscopy for determining the crystalline phase constituents due to their typical petrographical features. The samples have also analyzed by environmental scanning electron microscope in order to gain the topographical data about the grain boundaries in micro area furthermore determining chemical composition of the matrix after sintering [3,4]. Mineralogical phase decomposition can also investigated for understanding about the mass transport and hence secondary mineralization through out of the sintering. Quantitative X-ray fluorescence analyses on crystalline phases have been carried out after phase refining method based on Rietveld process to obtain the exact crystallographic preferred orientation. The samples are investigated via atomic force microscopy in order to characterize the grain boundaries and their defect through sintering via partial smelting [5]. All of the samples are from 5100 BC and they seem to have optimal firing because of the solidity of their body. Archaeological objects are preferred objects because they made by well processed soil and clay from their original region, furthermore their manufacturing techniques are actually primitive and therefore caused the better visibility of texture. One of the most interesting factors in such objects is the thin layer of coating covered the samples (slip) [6]. To characterize the coating layer high resolution microscopy methods (AFM) carried out to determine the grain boundaries between the surface and the slip. According to the chemical analysis and petrographical investigation, partial smelting is a reaction which would be controlled by different mineralogical parameter. In this case the ratio between Gehlenite/Anorthite, is an important thermodynamic interaction. On the other hand partial smelting of clay minerals causes the better adherence of texture. In the earthenware materials mostly appeared 2-3% clay minerals which are not the secondary mineralization, but also they are remaining of partial smelting. Partial smelting is also detectable through AFM on grain boundaries (Figure 1).

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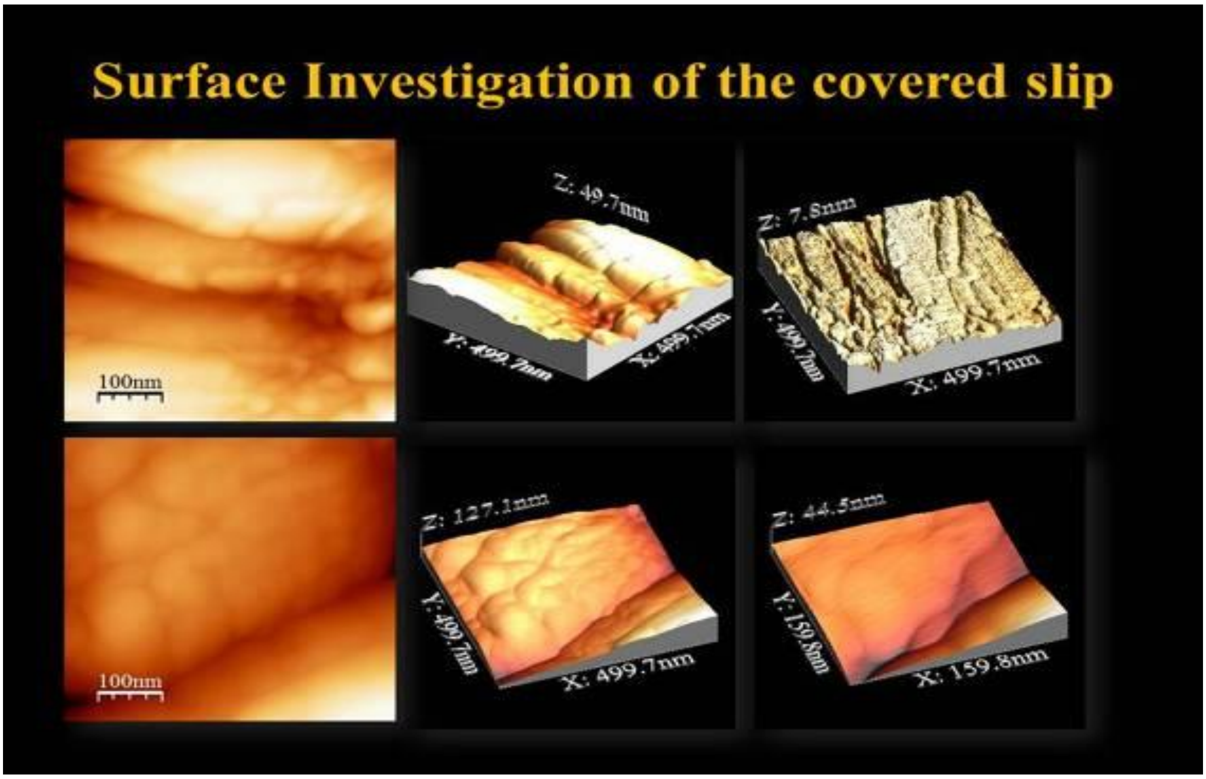

Figure 1. Surface characterization and partial smelting of the grain boundaries