ELECTROCHEMICAL EFFECTS ON MINERAL SURFACE PROPERTY MODIFICATIONS

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Direct information at a nanometer scale about surface products, their structure and surface distribution is vitally important to perform an efficient separation process of mineral beneficiation. This information is equally important for modification of surface properties of industrial minerals for various specific applications such as: fillers, composite materials, etc. The understanding of the mechanisms and kinetics of interaction of the first adsorbed organic molecules with mineral surfaces is the fundamental requirement to make possible the prediction, control and modification of the macroscopic surface properties that govern the efficiency of separation technologies or new material formulations. The recent instrumental development of surface sensitive techniques is contributing significantly to the increased emphasis being placed on molecular and atomic level surface characterization. The developed infrared external reflection technique has a very unique ability to study interface phenomena at a molecular level on heterogeneous substrates. The variety, precision and reliability of information about interface phenomena delivered by this technique are superior to other single techniques.

The flotation behavior of minerals depends on the nature, structure and surface distribution of their surface hydrophobic and hydrophilic species. The possibility of monitoring surface phenomena at molecular and atomic levels at the interfaces of natural minerals contacted with aqueous solution is vitally important for the understanding of the mechanisms and kinetics of surface phenomena and to design efficient flotation technologies. Improvement of selective separation of ore components is achieved by manipulation of solution conditions such as pH, Eh (aeration, reducing or oxidizing reagents), addition of different types of collectors at different concentrations, and modifiers such as activators or depressants. All these changes in solution compositions are performed in one aim, to make the valuable mineral components very hydrophobic whereas gangue components remain hydrophilic. This explains why the information collected directly from mineral surfaces is so important for understanding kinetic and thermodynamic relationships between the solution conditions and the nature and structure of the outermost layers that play a crucial role in surface modification for separation or other processes.

It is common that fundamental investigation of interaction of ore mineral components with aqueous solutions is performed in simple single mineral systems. Electrochemical studies are performed on selected single mineral specimens and mineral potential is imposed by potentiostat. This is a very different situation from real flotation of ore where at the same time numerous grains of different minerals are contacted in aqueous solution. Ores are usually complex, multicomponent, and heterogeneous systems and cannot be described by a single value. They interact with aqueous solution through complex dissolution/precipitation, adsorption/ desorption, or oxidation/reduction processes and ion exchange processes. For conductive minerals such as sulfides a direct contact of different mineral grains with different potentials results in galvanic effect, which involves flow of electrons from grains with lower potential to grains with higher potential. If a few minerals are present in suspension the surface phenomena that take place are very complex and difficult for detailed monitoring on each mineral component.

In this presentation hydrophobization of pyrite, galena and chalcopyrite surfaces by adsorption of amyl xanthate in classical single mineral systems and in multi mineral systems has been investigated spectroelectrochemically. Monitoring the formation of surface species directly on the mineral surfaces at submonolayer and monolayer levels has been carried out by multidiagnostic infrared reflection spectroscopy supported by spectral simulation.

Galvanic contact between grains of two different minerals has tremendous consequence on the type and amount of the adsorbed species. The detected changes could be very dramatic, from no adsorption to the formation of a few monolayers of strongly hydrophobic products (Figure 1). The produced experimental results in a multi mineral system provide realistic and precise information on the surface phenomena taking place on each mineral in a situation very close to real industrial flotation. Whereas the laboratory results found for a single mineral system could be very misleading. The proposed studies of multi mineral systems are vitally important and strongly recommended before any option for improving flotation selectivity and modification of flotation flowsheet is suggested.

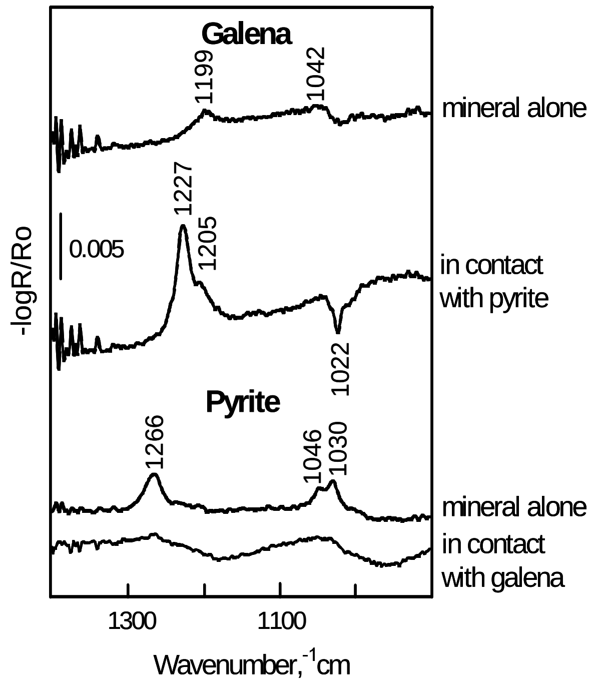

Figure 1. Reflection spectra of galena and pyrite contacted with amyl xanthate solution in single mineral systems and the minerals in galvanic contact.