Optimization by metallurgical processes of mechanical and electrical performances for nobles metals alloys

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Abstract: The range of fine wire products marketed by METALOR is based on silver, copper and palladium alloys with high electrical and mechanical performance, such as the NOVAE1 product which has a mechanical strength of 1.3 GPa and an electrical conductivity of 17 % IACS. The objective of this study is to understand the metallurgical mechanisms behind these characteristics and to take advantage of them in order to propose a new range of alloys with improved conductivity while maintaining high mechanical strength. The preliminary study carried out on the Cu-Pd binary system highlights the presence of the βCuPd phase below 600 °C, whose electrical conductivity is estimated at 30 % IACS. This phase is experimentally highlighted in the NOVAE1 fine wire and its formation is associated with an 8 % IACS increase in conductivity. It could therefore be a promising answer for the development of new alloys. Targeted experiments were carried out on seven grades of alloys developed and annealed for several months at 727 °C and 550 °C and then characterized by microprobe, XRD and SEM. These new data allow to refine the thermodynamic description of the Ag-Cu-Pd ternary system, in particular the miscibility gap, consisting of the two solid solutions cfc α1 and α2 and the extension of the βCuPd phase in the ternary system. The multi-scale characterization of the fine NOVAE1 wire highlights the complex, three-phase and nanostructured structure of the sample. These observations allow the development of phenomenological models of the mechanical and electrical properties of the wires by considering a matrix consisting of an Ag-rich α1 phase, associated with a soft phase in which are included hard phase domains rich in Cu and Pd, α2 and βCuPd. The wire characteristics are thus evaluated according to their chemical composition. This highlights the key parameters of the system: phase proportions, grain sizes, elastic modulus of the soft phase and electrical properties of the phases.