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 \( \beta \) CuPd 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 \( \alpha_1 \) and \( \alpha_2 \) and the extension of the \( \beta \) CuPd 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 \( \alpha_1 \) phase, associated with a soft phase in which are included hard phase domains rich in Cu and Pd, \( \alpha_2 \) and \( \beta \) CuPd. 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.