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An Age-hardenable Palladium Based Spring Alloy

Strong, light and rigid structural components are frequently produced by incorporating strong fibres of high elastic modulus into a lighter and weaker matrix. Glass or graphite fibres can thus be used to reinforce synthetic resin matrices, while other types of glass fibres are being employed to strengthen fine concrete mixes. With metals, however, fibre reinforcement has met with little success because at high temperatures the matrix tends inevitably to react with the strengthening phase, which is either dissolved or seriously weakened.

Dr K. H. Reiff of the Carl Haas spring factory has recently described (*Metall*, 1974, **28**, (7), 686–690) an attempt to develop a fibre-strengthened spring alloy in which no degradation of the strengthening phase occurs because it is always in thermodynamic equilibrium with its weaker matrix. With this object in mind he selected eutectic alloys based on the ternary system palladium-copper-gallium, in which the lamellar phase was an intermetallic compound, strong but ductile enough to allow the alloy as a whole to be heavily cold worked. The working and annealing procedure adopted produced a highly aligned fibre structure in the wires drawn from chill cast ingots. The proportion of the reinforcing fibres appeared to vary with the copper rather than with the gallium content of the alloys, and similar considerations applied to the hardness and tensile strength.

Wires having an initial diameter of 1.75 mm were cold drawn without annealing to a diameter of 50 μm, the area reduction ratio being approximately 1000:1. The heavily cold worked wires were then aged, and tensile values peaking at 260 kp/mm^2 or) rather more than 165 ton/in^2) were obtained after one hour at 425°C. Such tensile values are remarkably high for a ductile non-ferrous alloy and are comparable to those of maraging steels or of hard drawn wires of tungsten or rhenium. The high tensile strength was, however, due simply to age-hardening, and over-ageing reduced strength values catastrophically to the 80 ton/in^2 level, which was much below that of the hard drawn, un-aged wire.

These results, coupled with the fact that the elastic modulus of the fibrous wires was only marginally higher than that of pure palladium, show that the high strengths attained were a consequence of precipitation hardening alone and could not be attributed to fibre strengthening. Whatever the mechanism involved, however, a tensile strength approximately twice that of fully heat treated beryllium-copper is still impressive, and the heat treatment procedures required would seem well suited to the setting of hair springs. Certain applications might therefore be envisaged where economic justification could be found for the use of this strong but expensive palladium-based spring alloy.

A. S. D.