

Evolution and recent developments of 80%Ni permalloys

A. Demier,¹ H. Fraisse,¹ F. Godard,² and T. Waeckerlé¹

¹*Centre de Recherche APERAM, Rue P. Chevenard, 5810 Imphy, France*

²*Developpement-Marketing APERAM, Rue Chazeau, 5810 Imphy, France*

Facing the growing success of competing, cost reduced, high permeability and highly dynamic, amorphous or nanocrystalline ultra soft magnetic materials, how the old FeNi80 permalloys may survive ? Which properties, compromise, industrial advantages or innovation keep them in the race of enjoying performances, of interesting markets ? Which applications are going out or on the contrary are developed ? This presentation aims at reviewing the main recent tendencies influencing the development of FeNi80 alloys.

The remaining interest for these high nickel content alloys comes from the mixture of high level electromagnetic features (low and precisely controlled magnetocrystalline or magneto-elastic energies), from the mechanical ability to be easily machined into 3D shaped pieces, from the isotropic magnetic properties and from the medium Curie point: these features are recalled, with an emphasize of their relationships with precise chemical content, steelmaking routes or final heat treatments [1].

In the second part a set of applications are reviewed, aiming at understand what are the causes of death or creation of application-80 permalloy couple. A representative example of the former – the ground fault circuit breaker (GFCB) sensor– exhibits the ends of a rather important industrial market of FeNi80 alloys, despite remaining applications in very highly sensitive GFCB relay. On the opposite the growth of automotive torque sensor market, of room shielding and especially Rayleigh domain behavior for medical applications such as MagnetoEncephaloGraphy [2], of cryogenic shielding for large equipments devoted to fundamental physic research [3] or current transformers for medium voltage equipments ensure that such very soft magnetic materials remain very used.

It is shown that rather low permeability together with very low coercive field can be obtained with the help of final annealing under high fields (a few T) whereas the high frequency impedance behavior around the Curie point may be used as a contactless temperature sensor in any application requesting such function.

FeNi80 alloys appears to remain modern materials, associated with promising properties, behaviors and applications.

References:

[1] G. Couderchon, J.M.M.M. 96 (1991) 47-59

[2] A. Canova *et al*, IEEE Trans. Magn. 54, 3 (2018) 2000304

[3] M. Masuzawa *et al*, Proc. of SRF2013, Paris, France, WEIOD02, pp 1-4