Phase selection in several Al-based QC systems

W. Wolf[1], R. Schulz[2], C. Bolfarini[3], C.S. Kiminami[3] and W. J. Botta[3,*]

[1]Programa de Pós-Graduação em Ciência e Engenharia de Materiais, Universidade Federal de São Carlos, Rod. Washington Luiz, Km 235, 13565-905 São Carlos, SP, Brazil
[2]Hydro-Quebec Research Institute, 1800 Boul. Lionel Boulet, J3X 1S1 ,Varennes, QC, Canada
[3]Departamento de Engenharia de Materiais, Universidade Federal de São Carlos, Rod.Washington Luiz, Km 235, 13565-905 São Carlos, SP, Brazil

[*]Corresponding author: wjbotta@ufscar.br

Quasicrystalline alloys exhibit a variety of interesting properties, including high hardness, low friction coefficient, high corrosion resistance in acid medium, high resistance to oxidation and low thermal conductivity. Such features make the quasicrystalline forming alloys suitable candidates to be used as coatings, for example, in the petrol industry, which has major problems associated with corrosion, wear and formation of organic deposits in ducts during oil transport. In the present work several aluminum based alloys with the potential to form quasicrystalline phases, in the systems Al-Fe-Cu, Al-Cu-Fe-Cr, Al-Cu-Fe-Ni, Al-Ni-Co, Al-Ni-Co-Cr and Al-Co-Fe-Cr have been assessed, with the objective to develop new quasicrystalline compositions with improved corrosion, thermal and tribological properties. The alloys were produced by rapid solidification methods, such as melt-spinning, atomization, HVOF and arc melting in copper mold, and their microstructures were characterized by transmission and scanning electron microscopy (TEM and SEM), X ray diffraction (XRD) and differential scanning calorimetry (DSC). Evaluation of the properties included Vickers microhardness, pin-on-plate wear tests and thermal insulation tests. Despite previous report in the literature the alloys of the Al-Co-Fe-Cr system did not present the formation of quasicrystalline phases, instead we observed the formation of two intermetallic phases; quaternary approximants of Al_5Co_2 and $Al_{13}Co_4$ phases. The coatings fabricated from this alloy presented extremely low friction coefficient values and good thermal insulation behaviour. Quasicrystalline phases were observed in most alloys of the Al-Cu-Fe-(Cr,Ni) and Al-Ni-Co-(Cr) systems. The ternary Al-Cu-Fe showed great solubility of Cr within the QC phase and limited solubility of Ni. The Al-Ni-Co decagonal quasicrystal showed no solubility of Cr. Instead, addition of Cr resulted on the formation of a second QC, enriched in Cr.