Superconductivity in Ni-Bi system: a detailed microstructural study

Yutao Xing[1], Liying Liu[2], Isabel Liz Castro Merino[2], Guillermo Solórzano-Naranjo[3], Dante Franceschini[1], Elisa Baggio Saitovitch[2]

[1]Universidade Federal Fluminense (*LaMAR/CAIPE*) , [2]Centro Brasileiro de Pesquisas Físicas, [3]Pontificia Universidade Catolica do Rio de Janeiro

e-mail: xy@id.uff.br

It is well known that both crystalline Bi and Ni are non-superconducting down to 50 mK. However, bilayers of Ni and Bi prepared at room temperature and 80 K show superconductivity with T_c~4.0 K[1]. There were many different interpretations for the appearance of superconductivity in this system, but no agreement has been reached yet. In this work we present results of detailed microstructural study of the Bi-Ni interface and try to understand the origin of the superconductivity in Bi/Ni bilayers. The Bi-Ni bilayers have been prepared by pulsed-laser deposition (PLD) at 300 K and thermal evaporation at 4.2 K[2]. The Bi-Ni interface have been studied by high-resolution transmission and scanning transmission electron microscopy, supported by energy-dispersive x-ray spectroscopy (EDXS) analysis. The electric transport and magnetic properties have been measured using Quantum Design Dynacool PPMS. The structural and phase analysis results reveal that two superconducting intermetallic alloys (NiBi and $NiBi_3$) are formed by interdiffusion in the bilayers prepared by PLD at 300 K. Samples prepared at 4.2 K after annealing at 300 K do not show any superconductivity, which indicates that a crystalline Bi/Ni interface does not induce superconductivity in the case interdiffusion does not occur. These results offer a deeper understanding of the superconductivity in the Bi/Ni bilayer system: the NiBi and $NiBi_3$phases formed spontaneously during deposition are responsible for the superconducting transition in the Bi/Ni bilayer. It was also found out that $NiBi_3$phase has different nucleation and growth mechanism with different sequence of deposition[3].

Acknowledgments:
The author gratefully acknowledges PROPPI and PROGEM of UFF, FAPERJ and CNPq for the support.

References:
[1] J. S. Moodera and R. Meservey, Phys. Rev. B 42, 179 (1990).
[2] Liying Liu, et al., Phys. Rev. Materials 2, 014601 (2018).
[3] Liying Liu et al., Mater. Chem. and Phys. 260, 124112, (2021).