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Glow Discharge Surface Enrichment of Plain Sintered Iron

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Abstract – The development of simultaneous surface enrichment and sintering in confined cathode configuration has been developed in LabMat – UFSC in the last decade. The process was thoroughly studied for ASTM 430 alloy and the next improvement was decided to be the application of different alloys in surface alloying modification. The improvement with alloy ASTM 304L has shown thin enriched layers, which is explained by the presence of both nickel and chromium in the alloy composition. Scanning electron microscopy and tribological testing were done, comparing the new surfaces produced with those from PAVANATI [2].

Glow discharge sputtering processes are well known since 1970's decade. The technology is broadly applied in materials processing, from semiconductors eletronics to metallic materials processing. In metalic materials processing, the two head applications are plasma ionic nitriding and sputtering for thin film growing [1]. Various ranges of pressures and electrodes configuration have been studied, and since the ten last years, a confined cathode configuration is studied in LabMat – UFSC to provide simultaneous surface enrichment and sintering of metalic powders [2].

The present work consists in the study of the glow discharge surface enrichment of plain iron, simultaneously to the sintering practice. Tribological and microstructural evaluations were done to provide comparison with other works by PAVANATI [2]. Surface topography micrographies were taken, as well as enriched layer thickness was evaluated by EDX in sectioned samples.

The process was carried out in the range of 400 to 566 Pa. Tensions of 500 and 700V were used to discharge maintenance, while the pulse time was varied to obtain the required sintering temperature of 1373K. Four different atmosphere compositions consisting of argon and hydrogen were used in the experiment, in the volume reasons of 10/90, 25/75, 75/25 and 90/10, respectively.

Composition profiles showed that the content of chromium and nickel on the surface is proportional to that of the cathode composition. Multi-component diffusion provided lower nickel content than chromium far from the surface. Results from PAVANATI showed large enrichment profiles with only one alloying element. In this work only a few micrometers of layer were formed, explained by the complex diffusion of two elements, achieving about 10 μm. In Fig.1 a sintered sample profile at 1373K is showed. A thin homogeneous layer is observed. In Fig. 2 is presented a structure observed in some samples corners, some non-sintered particles with nanowires. This is done by presence of oxygen and formation of chromium oxide. This defect may degenerate tribological properties. The control of leaking has shown effective in better surface aspect control.

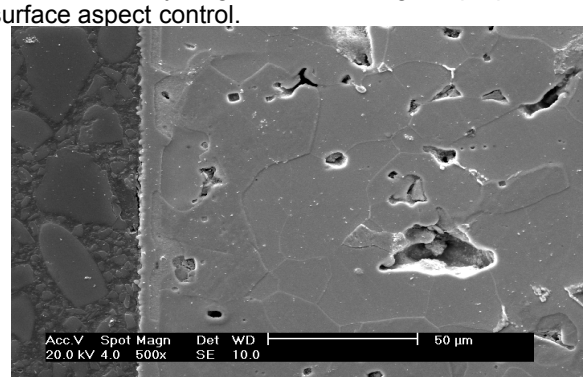

Fig. 1 – Layer formed at 1373K.

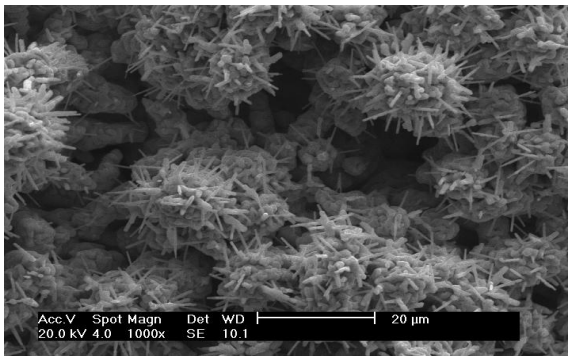

Fig. 1 – Surface aspect of sample enriched at 1373K.

References

[1] CHAPMAN, B. **Glow Discharge Processes:** Sputtering and Plasma Etching. New York, John Wiley & Sons, 1980. 406p.

[2] PAVANATI, H. C. **Sinterização de ferro puro com enriquecimento superficial simultâneo de cromo em descarga elétrica em regime anormal.** Florianópolis, 2005. 190 f. Tese (Doutorado) - Universidade Federal de Santa Catarina, Centro Tecnológico. Programa de Pós-Graduação em Ciência e Engenharia de Materiais.