Interface Structure of a V2O3 Layer Grown on Cu3Au (001) by Cs Corrected Transmission Electron Microscopy

H Calderon, H Niehus, B Freitag, D Wall, F Stavale, CA Achete

DOI: 10.1017/S1431927608085309
Microsc Microanal 14(Suppl 2), 2008

Interface Structure of a V_2O_3 Layer Grown on Cu_3Au (001) by Cs Corrected Transmission Electron Microscopy.

H. A. Calderon*, H. Niehus**, B. Freitag***, D. Wall,*** F. Stavale**** and C. A. Achete****.

* Depto. Ciencia de Materiales, ESFM-IPN, 07738 Mexico.
** Inst. für Physik, Humboldt Universität zu Berlin, Newtonstraße 15, Berlin 12489, Germany.
*** FEI Company, Achtsweg Noord 5, Eindhoven, The Netherlands.
*** Div. Metrologia de Materiais (DIMAT), Incetro, Xerem, RJ, Brazil and Prog. Engenharia Metalúrgica e de Materiais (PEMM), Univ. Fed. Rio de Janeiro, RJ, Brazil.

Vanadium oxides are materials of interest due to their electronic, magnetic and also catalytic properties. Interfaces between oxides and metals play an important role in the field of electronic packaging, gas sensors and combustion engines. In the case of V_2O_3 and Cu_3Au, the interfacial bonding is rather difficult to describe by a particular chemical bonding state, since the two component materials have strongly different electronic structures. Clearly, investigation of the local region at such an interface becomes important. At the moment there are some theoretical approaches available for the description of this type of interface but also a considerable lack of experimental data and in particular, reliable electron microscopy images. High resolution images (HRTEM) without any aberration correction have strong limitations since they cannot be directly interpreted either for the true position of atoms nor for the nature of the atomic species. In this investigation, the incoherent interface between vanadium sesquioxide and a Cu_3Au (001) substrate is described with the help of image corrected HRTEM and focal series reconstruction. The method to grow different thin oxide layers on a Cu_3Au (001) substrate has been developed and described elsewhere (CAOS [1]). In the present case it has been possible to grow a two dimensional multilayer of V_2O_3 (0001, corundum structure) on top of the Cu_3Au (001, $L1_2$ structure) substrate.

A model of the interface can be constructed from the experimental observations. The TEM sample has been prepared by means of a FIB (Helios FEI ®) dual beam equipment directly. An image corrected Titan microscope (FEI ®) was used. The zone axis orientation was chosen to be [011] in the Cu_3Au substrate. Figure 1 shows an example of the observations, the overview (fig. 1a) can be used to identify clearly the Cu_3Au on the left, the interface, the V_2O_3 layer as well as the cap layer of V. Figures 1b and 1c show an enlargement of a selected area in Fig. 1 a and the corresponding amplitude image from a reconstruction procedure, respectively. Figures 2a and 2b show a different orientation variant between the oxide and the substrate. Following a simple pattern recognition sequence, it is possible to identify the positions of the different atomic species in the images. This is depicted by means of a model pattern in Figure 2c. The images show many different features but the most apparent is the intensity of the last row in the Cu_3Au substrate which is similar to the intensity of some rows in the vanadium sesquioxide section. Such rows according to the pattern in Fig 2c correspond to V. This gives rise to the model for the interface exclusively based on experimental findings.

References

1. J. Middeke, R.-P. Blum, M. Hafemeister, H. Niehus, Surf. Sci. 587 (2005)
2. The financial support of Finep, CNPq-PROMETRO and CAPES is gratefully acknowledged. HAC acknowledges support from IPN to spend a sabbatical semester, grant CONACYT 45887 and COFAA-IPN.

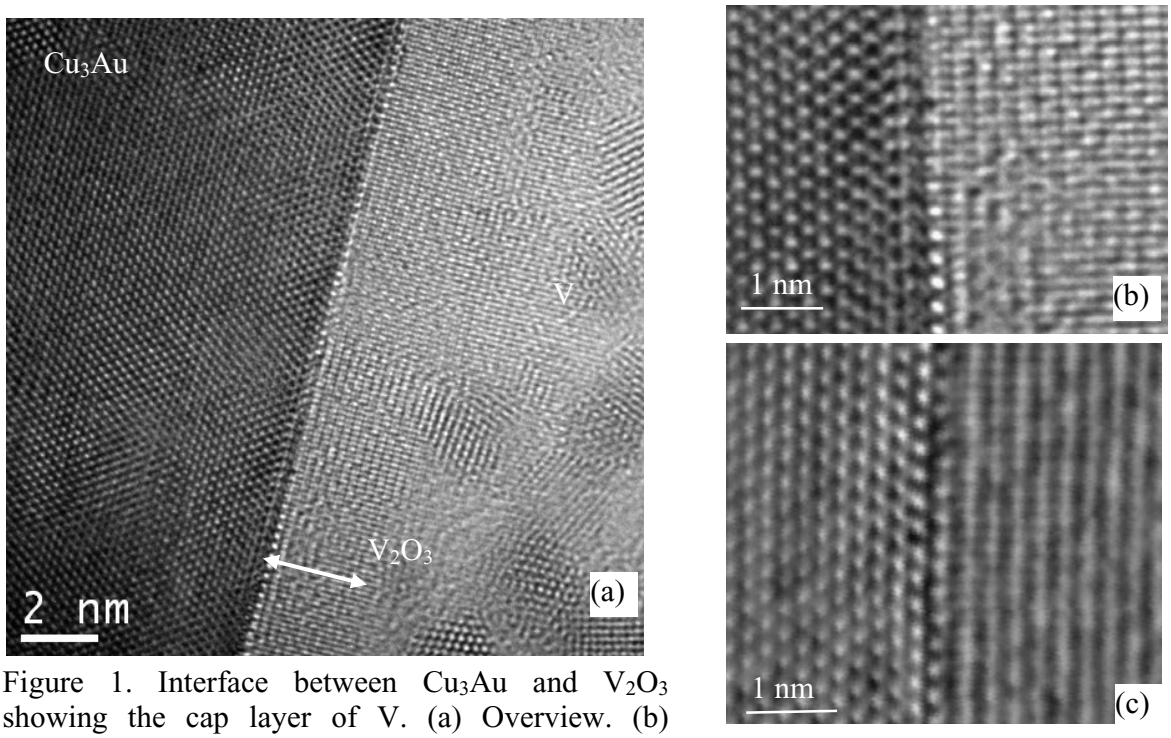


Figure 1. Interface between Cu_3Au and V_2O_3 showing the cap layer of V. (a) Overview. (b) Magnified image. (c) Corresponding amplitude image from exit wave reconstruction procedure.

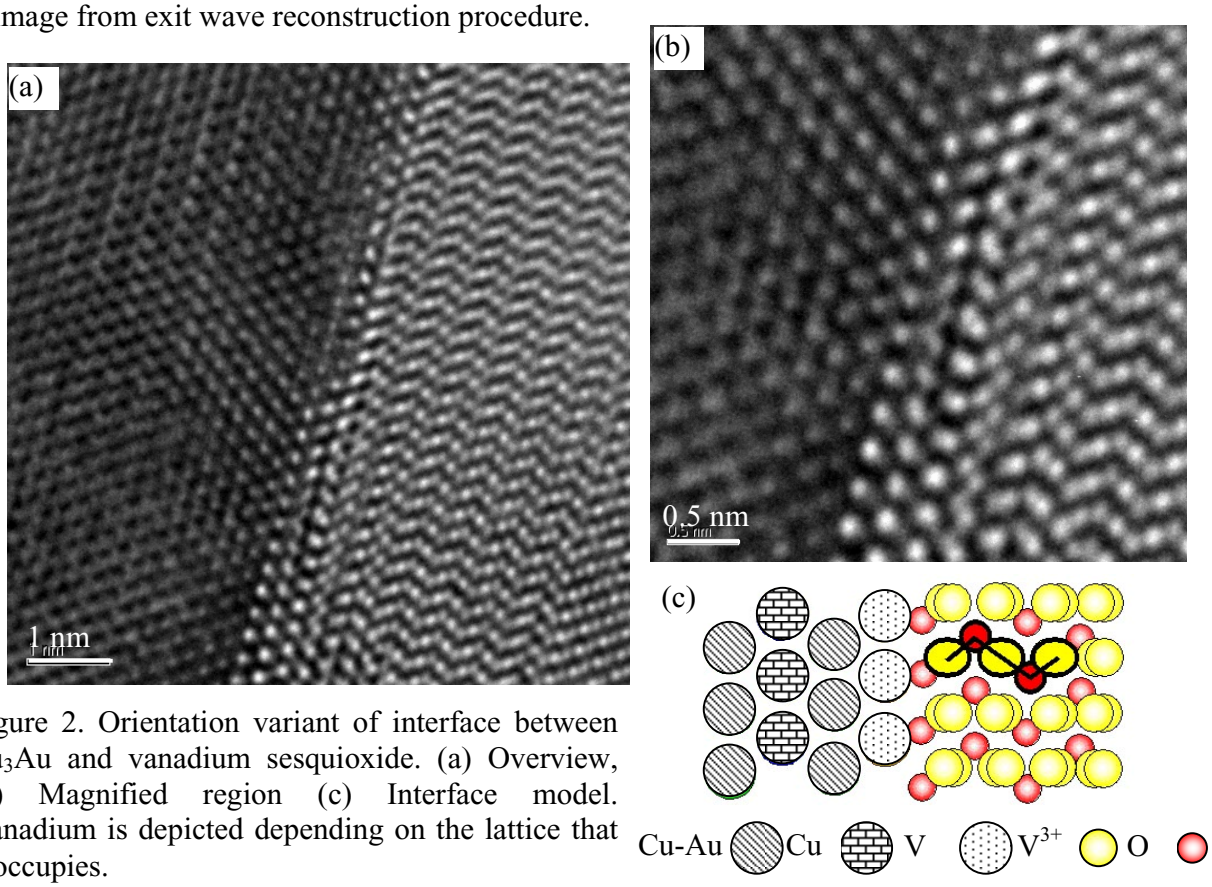
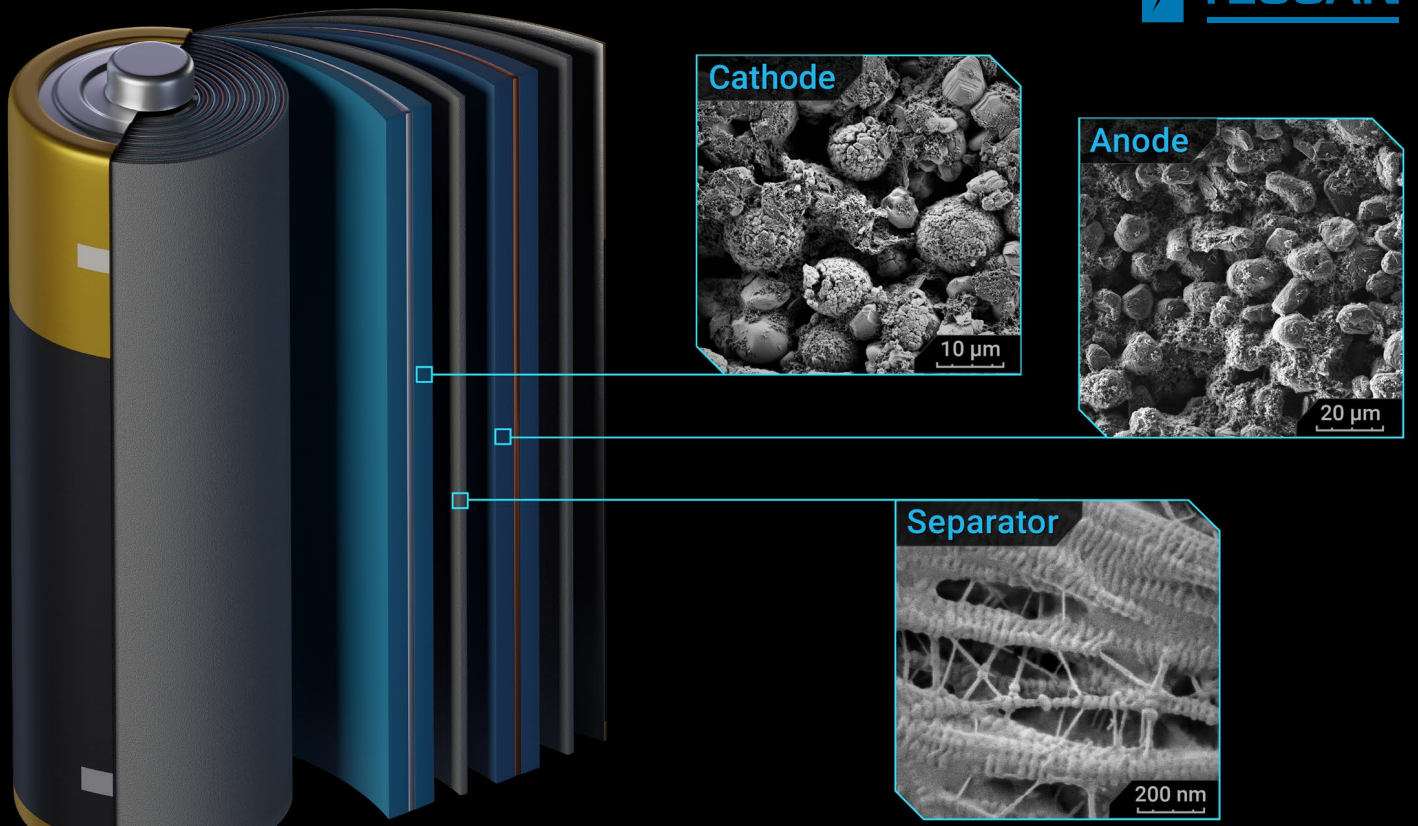


Figure 2. Orientation variant of interface between Cu_3Au and vanadium sesquioxide. (a) Overview, (b) Magnified region (c) Interface model. Vanadium is depicted depending on the lattice that it occupies.



TESCAN Solutions for Battery Industry

Power your Advanced Battery Technology and Research with TESCAN Solutions

info.tescan.com/batteries

Scan for more information