



**HAL**  
open science

## Crystallographic study of a Si-graphite interface by means of electron microscopy and EBSD

Thierry Epicier, Thierry Douillard, Hui Yuan

► **To cite this version:**

Thierry Epicier, Thierry Douillard, Hui Yuan. Crystallographic study of a Si-graphite interface by means of electron microscopy and EBSD. EBSD 2010, May 2010, Saint-Etienne, France. hal-02138707

**HAL Id: hal-02138707**

**<https://hal.science/hal-02138707v1>**

Submitted on 24 May 2019

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

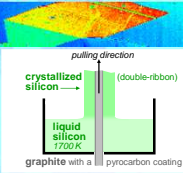
# Crystallographic study of a Si-graphite interface by means of electron microscopy and EBSD

T. EPICIER, T. DOUILLARD, H. YUAN

University of Lyon, INSA de Lyon, MATEIS, UMR CNRS 5510, Bât. B. Pascal, F-69621 Villeurbanne Cedex

## (1) background of the study

✓ The fabrication of low-cost solar cells remains largely based on the production of polycrystalline silicon films. The "Ribbon on Sacrificial Template" is an industrial process which consists in pulling a graphite ribbon in a high temperature furnace through a silicon melt, with a resulting double ribbon of silicon crystallized on both sides of the carbon substrate [1].

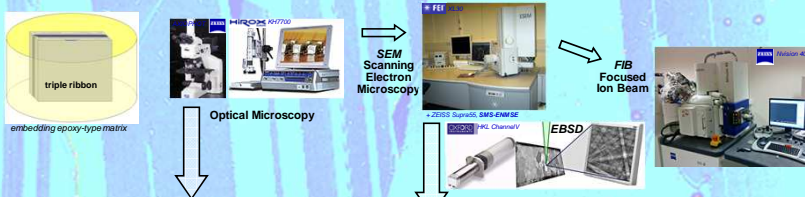


✓ Although graphite is protected by a pyrocarbon layer, chemical reaction between the graphite and liquid silicon can occur, thus leading to the formation of undesirable silicon carbide microcrystallites, which appear to develop either within the graphite ribbon, at the Si-C interface or within the silicon films.

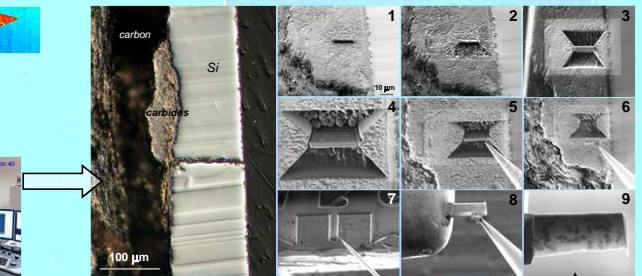
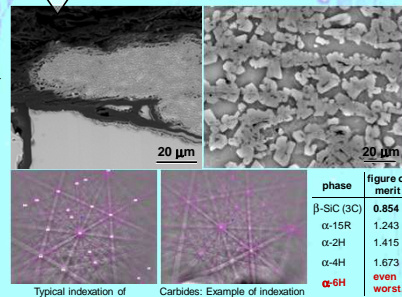
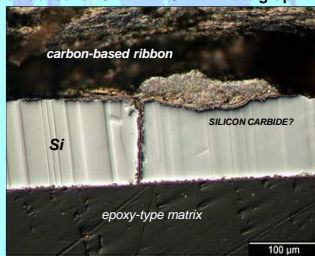
✓ In the frame of a general study devoted to the analysis of these complex interfaces, with the aim of understanding the formation sequence and mechanism of silicon carbide, crystallographic investigations have been undertaken in order to characterize the possible orientation relationships between SiC and the silicon. *In particular, does the 'cube-cube' OR occur?*

## (2) Experimental approach and results

✓ Preparation of a cross-section and observation techniques



a) evidence for CARBIDES within the graphitic layer

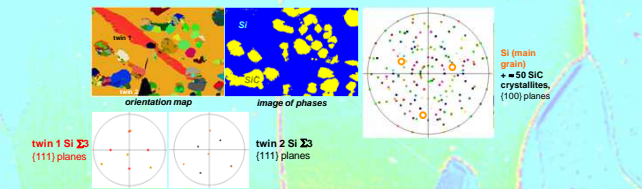
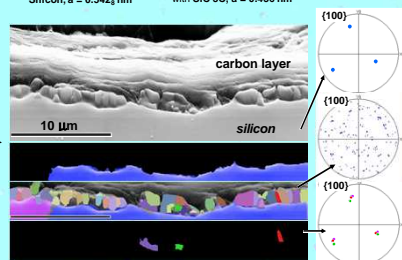
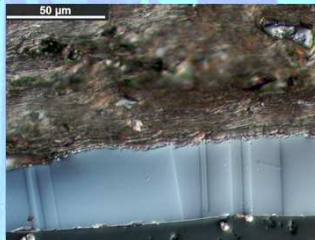


✓ TEM-DIFFRACTION work confirms the  $\beta$ -SiC cubic phase.

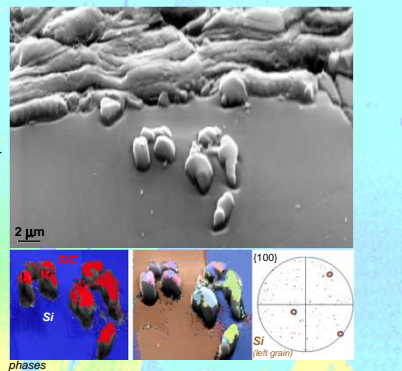
✓ There is NO systematic Orientation Relationship between the SiC crystallites and the Si (in particular the cube-cube O.R. as measured by the Automatic Crystal Orientation Mapping method [E. F. Rauch, U. Veloz, P. Porfido, G. Balogh, V. Mariani, J. Microscop. & Analysis (Nanotechnology Suppl.), nov. 2008, S5-S8])



b) evidence for CARBIDES at the interface

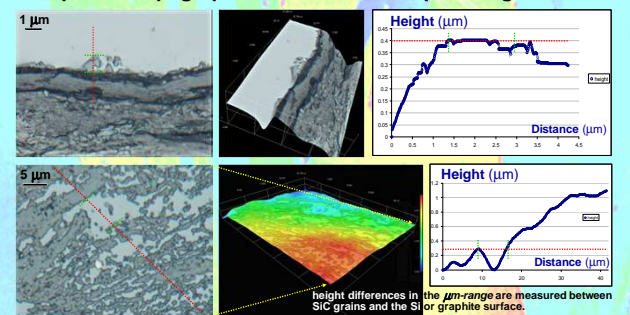


c) evidence for CARBIDES within the Si ribbon



## (3) Note: evidence for topography

✓ The great hardness heterogeneity (Si-SiC-graphite) leads to important topographic differences after polishing.



## (4) Conclusions

- ✓ most SiC crystallites are CUBIC. This finding is consistent with literature observations ( $\beta$  more stable than  $\alpha$  below 2000°C: [A.K. Søiland et al., *Materials Science in Semiconductor Processing*, 7, (2004), 39])
- ✓ although a 'cube-cube' Si-SiC O.R. has already been reported [J.W. Strane et al., *J. Appl. Phys.*, 76, 6, (1994), 3656, A. Severino et al., *J. of Appl. Phys.*, 102, (2007), 023518], NO systematic O.R. occurs here between SiC and Si.
- ✓ SiC crystallizes instantaneously (no C solubility in liquid Si at 1423 °C: less than 10-2 at. %) [J.R. O'Connor, "Silicon Carbide," in *The Art & Science of Growing Crystals*, ed. J.J. Gilman, John Wiley and Sons Inc., (1963)]. Rapid cooling of liquid Si leads to a very fast Si crystallisation and thus NO O.R. can develop.

## (5) Acknowledgements

C. BELOUET (SOLARFORCE, F-Bourgoin-Jallieu), P. STEYER (MATEIS, INSA-Lyon, F-Villeurbanne), E. RAUCH (SIMAP, INP-Grenoble), J.C. MENARD (C. ZEISS SMT SAS, F-Nanterre), S. SAO-JOAO and C. MAURICE (SMS, ENSM-St Etienne); The Centre Lyonnais de Microscopie, the french Agence Nationale pour la Recherche.