

PULSING BAFFLED CVD-BOAT REACTOR FOR SiC-COATING ON THE MULTI-WAFERS

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Introduction

Uniform SiC-deposition on the multi-wafers with LPCVD-boat reactor could be achieved by means of diffusion mode at a low value of Thiele modulus (>0.1), that is very low surface reaction and high diffusion rate [1,2]. So after the principle of Pulse column distillation [3] in this study in order to force the convection mode, a novel reactor, so called a baffled CVD-boat reactor using a pulse generator was developed, which consists of a twin tubular reactor inserted two boats with multiwafers allocated alternately to act as baffles with a baffle window ($f=0.1955$). In this way feed stream flows parallel between two wafer surfaces and cross through the baffle window during uniform CVD takes place on the surface of wafers. The problem of dead zones in the corner of baffle and reactor wall could be solved by means of periodic pulsing disturbances. For the visual Reynold's experiment the reactor was made of quartz glass. Flow patterns could be observed and photographed, followed by actual CVD of pyrolytic carbon from methane and SiC from MTS or mixture of silane, propane and hydrogen. The operation parameters were rpm and amplitude of the generator and flow rate ratio of precursor and carrier gas.

Experimental

In the visual experiment with or without pulsing generator (see Fig. 1) the wafer spacing was varied from 1/4 to 1/8 of the ratio between wafer space and diameter (3 inch) and introduced a color tracer through a capillary into the main stream during changing of flow rate ratio of carrier gas (H_2) to precursor (or color tracer). The frequency of the generator was changed from 25 to 200 rpm and amplitude 6.25 to 25 mm. The slits of wafer holder was made with wire cutting technique.

The flow pattern of the tracer through wafers and baffle windows was observed with digital camera. The actual CVD of pyrolytic carbon from methane was carried out with the stainless steel 316L, because of its easy deposition at low temperature of 600°C and various applications in the biomedical articles [4]. Besides on the pyrolytic carbon layer as buffer layer it could be deposited with SiC from MTS easily even at low temperature 600°C, while on the surface of wafer from the mixture of silane, propane and hydrogen only at high

temperature 1400°C. The experimental conditions of SiC-CVD were established as follows:

- a) H_2 /MTS 20/1 - 200/1
Deposition Pressure 1.33 kPa
Temperature 600 - 900°C
Evaporation Temp. of MTS 30°C
- b) Silane 6 ml/min (STP)
Propane 2 ml/min (STP)
Hydrogen 40 l/min (STP)
T=1300 - 1500°C; P=30 kPa

Results and Discussion

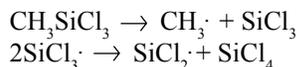
1) Visual Reynold's Experiment

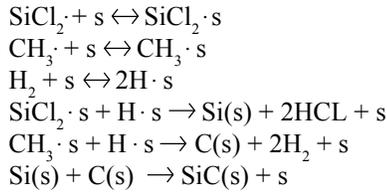
Fig 2 shows the flow Pattern of tracer through wafers and baffle window with wafer spacing of 1/4(a) and 1/8(b), respectively. The more narrower of wafer spacing, the more uniform distribution of tracer between two wafers could be realized without dead zones.

2) CVD of Pyrolytic Carbon on STS 316L With optimum wafer spacing of 1/8, partial pressure ratio (P_{CH_4}/P_{H_2}) of 5/1 and residence time of 1.5sec an uniform CVD of pyrolytic carbon from methane on the STS 316L was carried out at the temperature of 600°C (see Fig. 3). And the highest deposition rate, 73nm/sec occurred at this condition. Under low temperature up to 800°C an uniform CVD of pyrolytic carbon was possible on the etched surface of wafer and the epitaxial film was separated from the polished surface of wafers.

3) CVD of SiC

On the layer of pyrolytic carbon could be easily deposited SiC from MTS at 600°C. Fig. 4 shows a wafer holder (photo) with wafers deposited by pyrolytic carbon (a, SEM) and followed by SiC-deposition (b, SEM). After Langmuir-Hinshelwood's theory of the dual active site it was recognized that the mechanism of CVD-SiC was 1st order reaction as follows [5]:





$$\frac{P_{MTD}}{r_{dep}} = \frac{1 + K_{MTS}}{k} P_{MTS}$$

where $k = k_s \cdot K_{MTS}$

Conclusions

In this study we developed a novel CVD-Boat reactor with forced convection mode, so called "Pulsing Baffled CVD-Boat Reactor for Multiwafers". The dead zone and nonuniformity of CVD-reactor of the epitaxial film on the wafer could be solved by means of baffles and pulse generator. It was recognized with the CVD of pyrolytic carbon from methane, followed by SiC from MTS on the STS 316L at low temperature of 600°C, while on the wafer at high temperature of 1400°C, but by SiC from the mixture of silane, propane and hydrogen.

References

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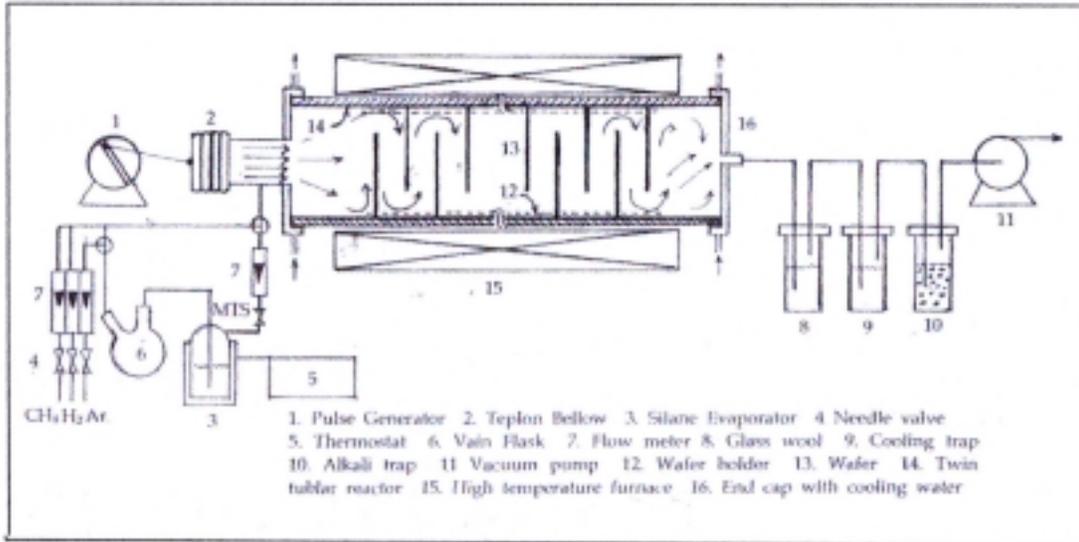


Fig. 1 Experimental apparatus

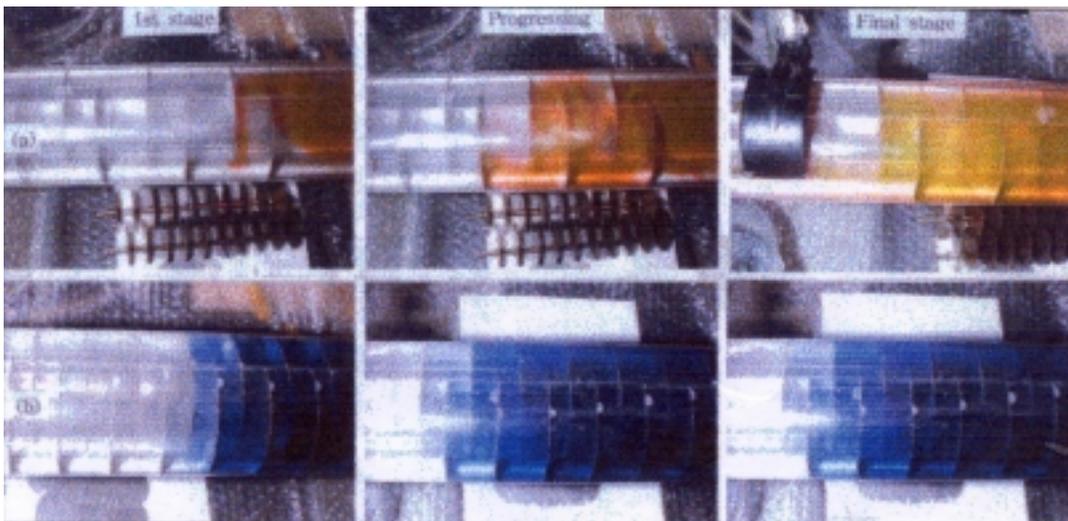


Fig. 2 Visual experiment of flow pattern of in the tracer in the baffled CVD-reactor with wafer spacing 1/4(a) and 1/8(b)

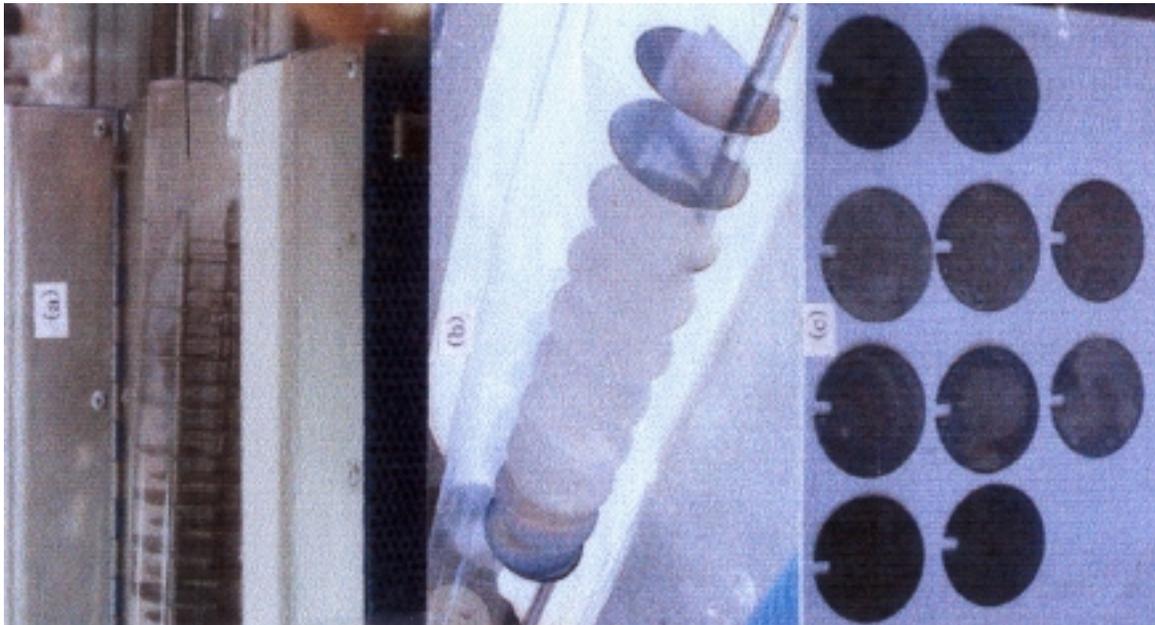


Fig. 3 pyrolytic carbon coating on the STS 316L in the Baffled CVD-Boat Reactor (a). coated samples on the Wafer holder (b) and coated samples (c)

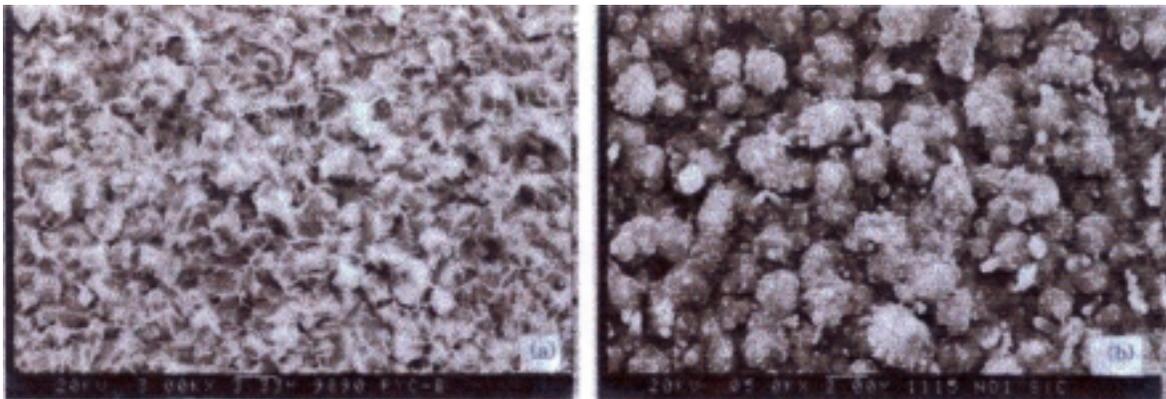


Fig. 4 SEM-photograph of pyrolytic carbon (a) coated 600t and followed by SiC (b) coating at 600°C on the wafers