CVD PROCESS ACTIVATED BY ATMOSPHERIC PRESSURE MICROWAVE PLASMA

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ABSTRACT

An atmospheric pressure microwave plasma is proposed for PCVD process.It has been shown that deposition efficiency of silica and germania can reach 100 % as reported by other authors for low pressure plasma.

1. INTRODUCTION

The Plasma activated Chemical Vapour Deposition /PCVD/process is recently sygnalized to be useful for preparation of silica fibers with good optical qualities/1-6/.This process using non-isotermal low pressure plasma offers potential advantages in the achieving high /till 100 %/deposition efficiency/3/. At low pressure the temperature of heavy particles in plasma is relatively low,hence during PCVD process usually an additional tube heating is there required.So that a number of the authors has applied here a high pressure Inductively Coupled Plasma/ICP/characterized by near LTE state/1,4/.However,in this case the deposition efficiency decreases.The other disadventage of ICP is very high rf power level /greather than 15 kW/necessary for sustaining the oxygen plasma.From the point of view of temperature needed for the process of CVD /1100-1800 K/ the gas temperature typically obtained in ICP/about 10000 K/ is certainly too high.

In our work for conducting the CVD process,an atmospheric pressure microwave plasma is proposed because of its properties such as: lower temperature and smaller power level needed to maintain the discharge,and at last because of its noticable departure from LTE state which probably caused the mentioned high deposition efficiency at low pressure operation /3/. Among various parameters of PCVD process studied,the deposition efficiency was the most important one and the results of its measurements are reported in this paper.

2. EXPERIMENTAL

The microwave plasma set up was almost the same as was used for NO synthesis /7/.Only the rectangular discharge cavity was modified enabling the operation with long /560 mm/ mooving quartz tubes. The set up was additionally equipped with a deposition system. The essential part of the experimental apparatus is schematically shown on fig.1.

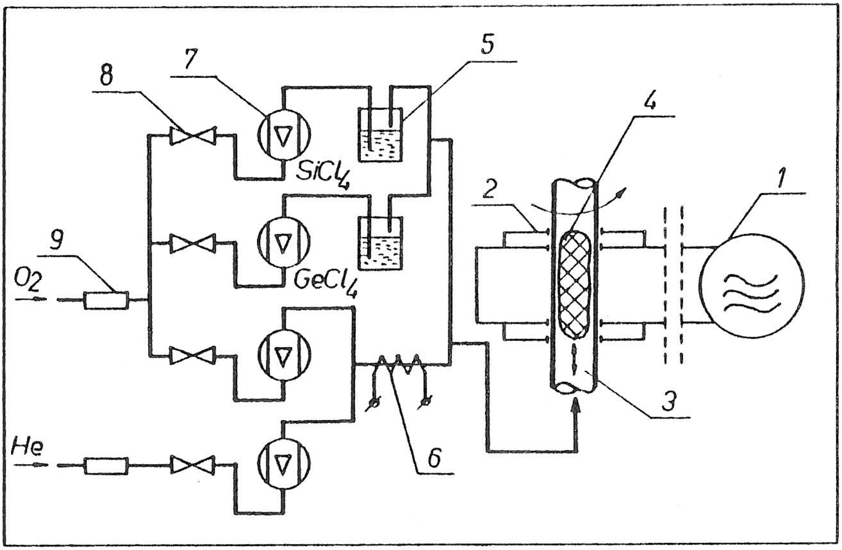

Fig.1. Schematic diagram of experimental device.
1-2.45 GHz, 2.2 kW max. d.c. power microwave generator,
2-waveguide discharge cavity,
3-quartz tube,
4-plasma,
5-saturation chamber,
6-gas preheater,
7-gas rotameter,
8-valve,
9-drying chamber.

The PCVD process was carried out using oxygen plasma with a small admixture of helium. Plasma was created inside the 10 and 17 mm i.d. quartz tubes crossing the rectangular cavity powered with microwave generator. The silicium and germanium tetrachlorides were used as starting materials. Reagents were introduced into the discharge region after previous mixing with oxygen. The mass rates of the reagents were precisely controlled by flow rates of oxygen passing through the saturating chambers kept at stabilized temperatures. To determine the deposition efficiency the increament of the quartz tube weight after the process was compared with mass of reagents used. The conditions for stable plasma generation were find to be as follows:gas flow rate of 0 - 33 cm^3/s, power level of 1. - 2.kW.

3. RESULTS

The typical results of experiments are shown in table 1.

Tube i.d. mm	Power in plasma kW	Chemical composition of layer	Deposition efficiency %	Estimated total error ±%
10.5	2.0	SiO_2	100	2
"	"	"	100	8
"	1.8	"	100	2
"	1.8	"	93	7
"	1.8	SiO_2-GeO_2	96	4
"	1.6	GeO_2	96	4
17.5	2.0	SiO_2	75	5
"	1.8	SiO_2-GeO_2	83	3

The obtained deposition efficiency was always /including the total error/ greater than 70% independently of the cladding material composition, and could even reach 100%. Better results were achieved for 10.5 mm i.d. tubes. The gas temperature was sufficiently high to ensure glassing of the deposited oxides in the same experiment. Glassed layers had a good quality confirmed by both X-ray and microscopic analysis.

ACKNOWLEDGEMENT

The Authors thank prof. A. Czernichowski for valuable discussions during the work.

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