quantum well. Such a configuration is now under development but requires additional investigations into the QW growth conditions in order to minimise the dark current.

To date, convenient pseudomorphic growth conditions have been established for wavelengths ranging from 1.8 to 2.15μm using MOCVD epitaxy. Conditions for extension up to 2.3μm have been obtained experimentally by SSMBE using InAs/InGaAs fractional monolayer superlattice growth to increase the thickness of the strained QW [5].

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Characteristics of SiC-based thin-film LED fabricated using plasma-enhanced CVD system with stainless steel mesh

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A conventional plasma-enhanced chemical vapour deposition (PECVD) system with a stainless steel mesh attached to a cathode was used to fabricate an SiC-based thin-film light-emitting diode (TFLED) at a low temperature (~180°C). The obtained TFLED had a brightness (B) of 1060cd/m² at an injection current density (J) of 600mA/cm² and a threshold voltage (V_{th}) of 12.6V, which were much better than those of 330cd/m² and 18.5V for an amorphous SiC-based TFLED fabricated by the same PECVD system without a stainless steel mesh.

Introduction: Hydrogenated amorphous silicon (a-Si:H) has been studied widely. In 1976, Pankove *et al.* first reported infrared electroluminescence (EL) from the Schottky barrier interface of a-Si:H and also from an a-Si:H *pin* junction at low temperature [1, 2]. Recently, a series of visible thin-film light-emitting diodes (TFLEDs) made of a-SiC:H have been presented by Hamakawa *et al.* [3 – 7]. As compared to conventional crystal LEDs, a-SiC:H-based TFLEDs possess several disadvantages, e.g. lower brightness (B) and higher threshold voltage (V_{th}). The brightness of a-SiC:H-based TFLEDs has to date been insufficient for practical applications.

In 1993, silicon epitaxial growth with PECVD and a stainless steel (s.s.) mesh at a low temperature (~300°C) was reported [8, 9]. In this Letter, we describe the use of this idea to fabricate simple SiC-based thin-film TFLEDs at low temperature (~180°C). We used this method to improve the characteristics of SiC:H-based TFLEDs.

Device fabrication: The PECVD system (ULVAC CPD-1108D) with an s.s. mesh, used in this study, is shown in Fig. 1. A 40 mesh s.s. screen was attached to a cathode. The s.s. mesh can maintain the plasma between the mesh and the lower electrode, allow the energetic precursors to pass, minimise the high energy bombardment of ions on the substrate surface, and reduce the deposition of polymer on the substrate surface [8]. The PECVD system with s.s. mesh enables the epitaxial film to be deposited at a lower temperature [8].

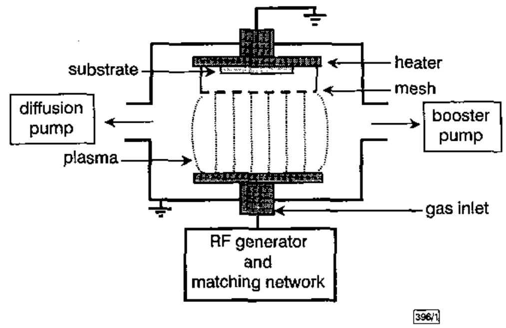

Fig. 1 *PECVD system with stainless steel mesh used for depositing film*

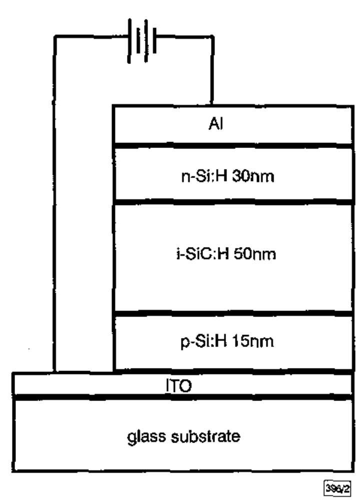

Fig. 2 *Schematic diagram showing cross-section of obtained SiC:H-based TFLED*

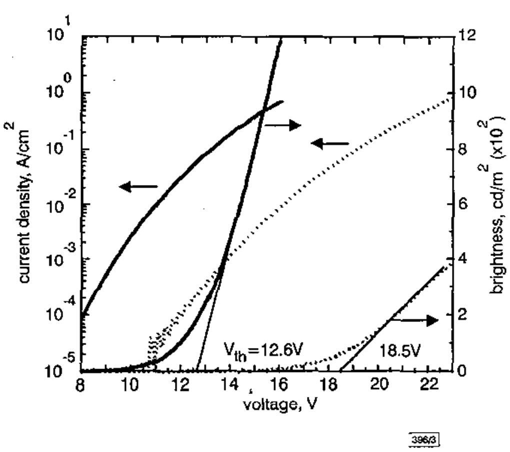

Fig. 3 *Current density and brightness against applied voltage for the TFLEDs fabricated using PECVD system with and without stainless steel mesh*

——— mesh
– – – – no mesh

The schematic cross-section of the simple SiC:H-based TFLED is shown in Fig. 2. All of the SiC and Si films in the TFLED were deposited with a PECVD system with or without an s.s. mesh. The p-(15nm) and n-(30nm) type Si films were deposited using the SiH_4 (25% in H_2) source gas, and the dopants B_2H_2 (1% H_2) and

PH_3 (1% in H_2), respectively, and the *i*-type SiC:H layer (50nm) was grown with SiH_4 (25% in H_2) and C_2H_2 (pure) source gases. The external Al electrode was then deposited by using an E-gun deposition system. Finally, the samples were placed into a rapid thermal annealing system and annealed under a hydrogen ambient at 280°C for 3min. to reduce the contact resistance between the Al and Si:H layer.

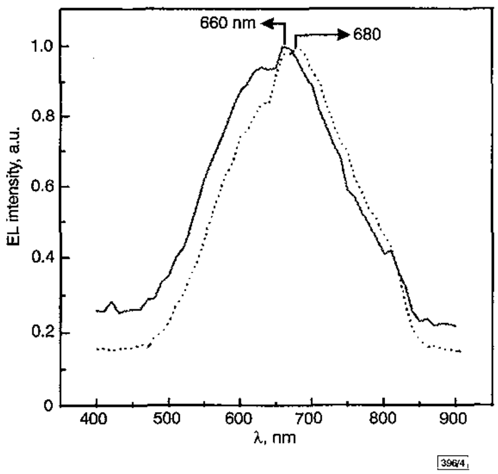

Fig. 4 *EL spectra of TFLED fabricated with and without stainless steel mesh*

Applied voltage = 15V
——— mesh
- - - - no mesh

Results and discussion: Fig. 3 shows the *J* (current density)-*V* and *B* (brightness)-*V* curves of the obtained SiC-based TFLED. As can be seen from this figure, the SiC-based TFLED had a *B* = 1060 (330)cd/m², at *J* = 600mA/cm², and a V_{th} of 12.6 (18.5)V when fabricated using a PECVD system with (without) an s.s. mesh. V_{th} was defined as the *x*-axis intercept obtained by linearly extrapolating the linear portion of the *B*-*V* curve. Therefore, if an s.s mesh was used in the PECVD system, the *B* and V_{th} of TFLED could be improved significantly.

As shown in Fig. 4, the EL spectra of the TFLEDs fabricated by using a PECVD system with and without an s.s. mesh peaked at 680 and 660nm wavelengths, respectively. The peak wavelength of the EL spectrum would be related to the energy levels of injected carriers and the optical bandgap of the SiC:H layer. The TFLED fabricated with an s.s. mesh had a longer peak wavelength compared to that of the TFLED fabricated without an s.s. mesh at the same applied voltage (~15V), and the longer peak wavelength might result from the slightly lower bandgap of the obtained SiC:H film deposited using a PECVD system with an s.s. mesh.

Conclusion: The SiC:H-based TFLED obtained using a PECVD system with a stainless steel (s.s.) mesh had much better optoelectronic characteristics compared to those of the TFLED fabricated without an s.s. mesh. The obtained TFLED had a brightness of 1060cd/m² at an injection current density of 600mA/cm² and a threshold voltage of 12.6V. The improvements in the optoelectronic characteristics for this TFLED are mainly due to the s.s. mesh, which results in a deposited film with less plasma damage.

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Precise SDH frequency operation of monolithic modelocked laser diodes with frequency tuning function

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Frequency tuning has been achieved in monolithic modelocked laser diodes through electrical control of the distributed Bragg reflector (DBR) effective length. A 0.5% frequency-tuning range has been obtained, which is wide enough to compensate for the frequency error that results from cavity length uncertainty when the usual cleaving process is used. Low-jitter 9.95328GHz SDH frequency operation with a 6ps transform-limited pulse output has been demonstrated.

Modelocked laser diodes (MLLDs), with their compactness and stable coherent-short-pulse output, are attractive optical pulse sources for ultra-wideband RZ (return-to-zero) transmission and long-span soliton transmission systems. To use MLLDs in such systems, the wavelength and pulse-repetition frequency must be precisely controlled. To date, wavelength control in monolithic MLLDs with a distributed Bragg reflector (DBR) has been reported [1, 2]. However, sufficient precision in the pulse-repetition frequency has not yet been obtained. The pulse-repetition frequency of an MLLD is determined by the round-trip time of the optical pulse in the cavity, so precise fabrication of the cavity is essential for accurate frequency operation. In actual operation, the frequency of an MLLD is locked to the system clock through an active or a hybrid modelocking method. To enable this, the cavity length is precisely controlled within the locking range, typically within 0.1%. When fabricating the device, however, the cleaving position error is usually ~20μm, which corresponds to a 0.5% frequency error for a 4.3mm long MLLD operated at 9.95328GHz (the SDH frequency). To produce MLLDs with the required system frequency using the current fabrication process, a frequency-tuning function is needed to compensate for the fabrication error.

Here, we describe a method for tuning the repetition frequency of monolithic MLLDs by means of electrical control of the DBR effective length. The monolithic MLLD used in this study, which has a DBR at one end of the cavity, is shown in Fig. 1. For the DBR-integrated MLLDs, the cavity length is defined by using the effective length or penetration depth of the reflector for the DBR section. According to coupled-mode theory, the effective length of the DBR L_{eff} for the actual length of L is defined by the grating coupling coefficient κ and internal loss α [3] as