TMS
Minerals • Metals • Materials

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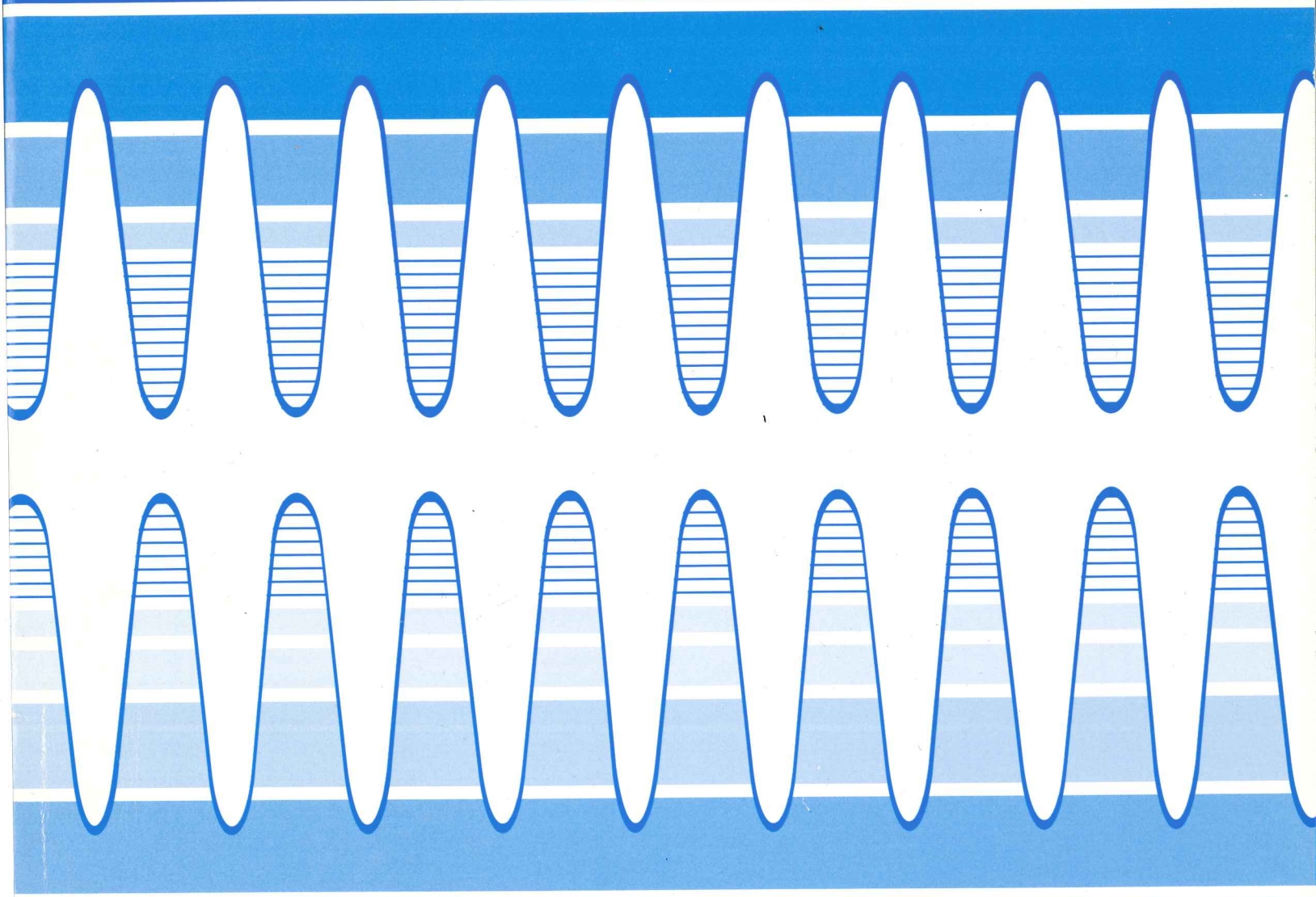

1997 ELECTRONIC MATERIALS CONFERENCE

Technical Program with Abstracts

higher, the grain structure is highly dendritic, and grains often show single molecular layer steps of pentacene. Thin film transistors fabricated using pentacene layers deposited onto smooth SiO_2 have shown field-effect mobility larger than 1 cm^2/V-s. Films deposited onto SiO_2 films roughened by reactive ion etching have dramatically different characteristics. This SiO_2 has a rms roughness of about 30 Å and films deposited at all temperatures used here show only small grains and no molecular steps. Thin film transistors fabricated using pentacene layers deposited onto rough SiO_2 have significantly degraded characteristics and greatly reduced field-effect mobility.

We find that treating the SiO_2 surface with a self-organizing molecule (SAM) can also greatly reduce pentacene film ordering. Treated SiO_2 surfaces remain relatively flat on a microscopic scale; AFM typically shows surfaces with rms roughness <3 Å. However, the atomic scale interactions of at least some SAMs lead to pentacene films with poor ordering, even for depositions held at elevated temperature. By using various SAMs, we are able to grow either poorly-organized, or well-organized layers. Interface control is likely to be significant problem for organic devices, and SAMs offer a powerful technique to vary the character of the interface. This research was supported by the Defense Advanced Research Project Agency (DARPA) #F33615-94-1-1464 and the National Science Foundation (NSF) #ECS-9409444.

*Tom R. Hebner may have been added as author.

10:40AM, B3+
Ink-Jet Printing of Highly Fluorescent Molecularly Doped Polymers: C.C. WU, D. Marcy, M. Lu and J.C. Sturm, Department of Electrical Engineering, Princeton University, Princeton, NJ 08544

Patterning of organic thin films for individual devices in multicolor organic light emitting devices or displays has been problematic because of the difficulty associated with the wet processing of organic thin films and photolithography process after the organic deposition. In this paper, we demonstrate simultaneous deposition and patterning of fluorescent molecularly doped polymer (MPD) thin films directly by ink-jet printing.

To avoid possible thermal damage to the active organic materials from thermal ink-jet printing head, we employ a ink-jet printing head with a piezolectric transducer, in which the polymer solution droplet is ejected from the nozzle by a pressure wave when a voltage is applied to the transducer surrounding the nozzle tube. The solution is applied from cartridge to the nozzle through a thin tube by capillarity. The polymer solution used is similar to that used for making devices by spin-coating, but with reduced concentration and therefore viscosity to assure the smooth passage of the polymer solution through the printing head. The MPD composition used in this work is poly(N-vinylcarbazole):coumarin 6 ~ 100:1 (wt), with the concentration ranging from 2 mg/ml to 10 mg/ml.

We have used the ink-jet printer to print small dots on papers and ITO-coated plastic thin films. The polymer dot size is about 200 µm and the height of the dot could be a thin as several hundred angstroms, depending on the solution concentration. The dot size on ITO-coated plastic thin films will also depend on the wetability of the ITO by the solvent carrying the chemicals. The small dots of the green dyed coumarin 6-doped polymer shows green fluorescence under UV excitation, similar to the spin-coating films. Arbitrary patterns formed by these dye-doped polymer dots, such as letters and Arabic numbers, has been printed with a ~90 dpi printer containing such piezoelectric ink-jet printing heads. More work is in progress to fulfill full-color (R,G,B) printing of fluorescent polymers.

11:00AM, B4
Operational Characteristics of Organic Crystals for NLO and EO Applications: N.B. Singh, T. Rajalakshmi, I. Liberman, Science and Technology Center, Northrop Grumman Corporation, 1350 Beulah Road, Pittsburgh, PA 15235; N. Fernelius, D.E. Zelmon, Materials Directorate, Wright Laboratory, Wright-Patterson AFB, OH 45433; M.E. Glicksman, Materials Science and Engineering Department, R.P.I., 110 8th St., MRC-104, Troy, NY 12180

Organic crystals have shown promising properties for their applications in ultraviolet and near-infrared wavelength region. Very high values of the second harmonic conversion efficiency and the electo-optic coefficient have been observed. Thermal and environmental stability, growth of large optical quality crystals and fabricability are main concerns which prohibit the applications of these crystals in practical devices. Due to the lack of experimental data on physical properties and solidification of nonlinear optical organic materials, growth technology is not very developed. We have studied binary organic alloys based 3.nitoraniline (m.NA) and 2-chloro-4nitoraniline (CNA) for their solidification behavior, crystal growth and second harmonic conversion efficiency. Crystals were grown from the melt using the Bridgman method. The second harmonic efficiency was measures by using a beam of 1.5 mm diameter spot 10ns pulse and 1.06 µm wavelength. The measured efficiency of 7.7% with a 2mm fabricated sample indicated that a crystal of 1 cm length will produce very high efficiency. Crystal did not show any damage when exposed to 1.06 µm radiation at 1mJ per pulse (10 Hz repetition rate, 0.35 mm spot size and 10 ns pulse) corresponding to a 100MW/cm^2 power density. These results will be compared with the commercially available inorganic crystals.

11:20AM, B5
LATE NEWS

11:40AM, B6
LATE NEWS

Wednesday AM, June 25, 1997

Session C: Characterization of LT-GaAs and Composite Materials

Room: Cherokee

Session Chairman: K.G. Eyink, Wright-Patterson Air Force Base, ML/MLBM, 2941 P St., Suite 1, Dayton, OH 45433-7750
Co-Chairman: J.M. Woodall, Purdue University, School of Electrical Engineering, 1285 EE Bldg., W. Lafayette, IN 47907-1285

10:00AM, C1
Precipitation in Fe-doped GaAs or Ag-implanted $Al_{0.3}Ga_{0.7}As$: J. YE, J.C.P. Chang, D.T. McInturff, M.R. Melloch and J.M. Woodall, School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN 47907; D.T. Crouse and D.D. Nolte, Physics Department, Purdue University, West Lafayette, IN 47907

The objective of this study is to search for an alternative metal/semiconductor composite to low-temperature-grown GaAs, i.e. the GaAs:As composite. GaAs:As containing a high density of As precipitates embedded in GaAs matrix has demonstrated many interesting optical and electrical features, such as high resistivity and sensitivity to subbandgap light. Calculations by Nolte[1] show that better metals can have stronger effects on the dielectric and optical properties of composites than the semi-metallic As. We have studied composites formed by ion implantation of various metals, including Cr, Cu, Fe, Ni, and Ag, into GaAs followed by subsequent anneals. Our results with the Fe-implanted GaAs,[2] further demonstrate the ability to fabricate a ferromagnetic/ semiconductor composite, which consists of ferromagnetic Fe_3GaAs precipitates in GaAs. Recently, we have synthesized the iron/GaAs composite by molecular beam epitaxy (MBE).[3] In this paper, we report transmission electron microscopy (TEM) studies of phase identifications and precipitation behaviors in Fe-doped GaAs grown by MBE and Ag-implanted $Al_{0.3}Ga_{0.7}As$. Unlike most of the metals that tend to form compounds with Ga or As while precipitating, we have obtained pure Ag/ AlGaAs composites by Ag implantation.

The Fe-doped GaAs sample was grown at 600 or 400°C by co-depositing 1% Fe during MBE. Results indicate that different growth temperatures cause different phases of precipitates to be formed. Composites grown at 400°C have ellipsoidal precipitates with sizes ranging from 33 to 55 nm in diameter. TEM Analyses reveal that these precipitates are orthorhombic FeAs with an unfixed orientation relationship to the GaAs matrix system. This is compared to the hexagonal Fe_3GaAs precipitates observed in Fe-doped GaAs grown at 600°C and Fe-implanted GaAs.

The Ag-implanted $Al_{0.3}Ga_{0.7}As$ sample was implanted with $3x10^{16}$ ions/cm^2 of Ag at room temperature and then annealed at 650°C for 30 min. TEM analysis reveals a composite consisting of faceted precipitates with sizes ranging from 2 to 20 nm. These precipitates are identified to be elemental Ag (FCC structure with lattice constant a=0.409 nm) with orientation relationship to $Al_{0.3}Ga_{0.7}As$: $(200)_{Ag}//(200)_{AlGaAs}$, $(02\text{-}2)_{Ag}//(02\text{-}2)_{AlGaAs}$, and $[011]_{Ag}//[011]_{AlGaAs}$. Either Ag_9As