External Awards

Papers Published in Technical Journals and Conferences

MOVPE growth of single-crystal hexagonal AIN on cubic diamond

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J. Cryst. Growth, Elsevier, Vol. 311, pp. 2825–2830, 2009.

We have obtained single-crystal aluminum nitride (AIN) layers on diamond (111) substrates by metalorganic vapor-phase epitaxy (MOVPE). When the thermal cleaning temperature of the substrate and growth temperature of the AIN layers were below 1100ºC, the AIN layer had multi-domain structures mainly consisting of rotated domains. An interface layer, consisting of amorphous carbon and poly-crystal AIN, was formed between the AIN layer and the diamond substrate. On the other hand, when the thermal cleaning temperature and growth temperature were above 1200ºC, a single-crystal AIN layer was grown and no interface layer was formed. Therefore, we attribute the multi-domain structures to the interface layer. Even when the growth temperature was 1100ºC, if the thermal cleaning was performed at 1200ºC, the single-crystal AIN layer was obtained, indicating that the thermal cleaning temperature of the substrate is a critical factor for the formation of the interface layer. The epitaxial relationship between the single-crystal AIN layer and the diamond (111) substrate was determined to be $[0001]_{AIN}\|[111]_{diamond}$ and $[1\bar{1}0]_{AIN}\|[1\bar{1}0]_{diamond}$. The AIN surface had Al polarity and no inversion domains were observed in the AIN layer.

Early word learning in young Japanese children

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International Conference of JSLS2009, Japanese Society of Language Science, Vol. 11, pp. 17–20, Tokyo, Japan, 2009.

The first study demonstrates that, by 20 months of age, Japanese-speaking children are able to use noun and verb morphosyntactic cues in word learning even when two interpretations, an agent and an action, are equally possible. Furthermore, they are able to do so even when these cues do not coincide with perceptual cues. In fact, this study provides the first evidence that children under two years of age are able to overcome perceptual salience or preference and use morphosyntactic cues in verb learning. In the second study, we found that 20-month-olds, but not 18-month-olds, are able to extend novel verbs to previously unseen instances with a novel agent when they are habituated to the action events with multiple exemplars. These findings together provide strong evidence for the view that children's representations of both noun and verb morphosyntactic information are abstract enough to guide early word learning.

A New Method of Reducing Exact Computations to Obtain Exact Results

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ISSAC2009, ACM, Vol. 1, No. 1, pp. 14–15, Seoul, Korea, 2009.

We propose a new method that reduces the number of exact computational steps needed for obtaining exact results, for a certain class of algebraic algorithms. This method is the floating-point interval method using zero rewriting and symbols. Zero rewriting, which is from stabilization techniques, rewrites an interval coefficient into the zero interval if the interval contains zero. Symbols are used to keep track of the execution path of the original algorithm with exact computations, so that the associated real coefficients can be computed by evaluating the symbols. The key point is that at each stage of zero rewriting, one checks to see if the zero rewriting is really correct by exploiting the associated symbol. This method mostly uses floating-point computations; the exact computations are only performed at the stage of zero rewriting and in the final evaluation to get the exact coefficients. Moreover, one does not need to check the correctness of the output.

Determining Divisibility between Polynomials with Inexact Coefficients

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We provide a method of determining whether there exist some $p \in P$ and $f \in F$ such that p is divisible by f for a pair of real multivariate interval polynomials, P and F. Although this problem is written as a

feasibility problem for a system of nonlinear algebraic equations, it is an NP-hard problem and is thus difficult to solve. Our approach is iterative based on interval analyses, which outputs the regions containing the solutions if the system is feasible; otherwise, it outputs the fact of infeasibility. We also propose two methods for where the system of algebraic equations is underdetermined: the first obtains the regions that enclose all solutions, and the second obtains the solution that minimizes error in the Euclidean norm.

Photoluminescence of highly excited AIN: Biexcitons and exciton-exciton scattering

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Appl. Phys. Lett., AIP, Vol. 95, p. 031903-, 2009.

Low-temperature photoluminescence spectra of nominally undoped high-quality AIN layers on SiC and AI_2O_3 substrates are reported. Under high excitation conditions, we observed several bands that increased superlinearly with the excitation density. Based on temperature and exicitation level dependences recorded on different samples, we identified a band 36 meV below the free A-exciton transition as due to exciton-exciton scattering P_2 band and a second band down-shifted from the A-exciton transition by 27 meV as due to biexciton recombination. The combined data yield an exciton binding energy of 48 meV.

Comparison of neuronal cell adhesiveness of materials in the diX (Parylene) family

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Neuroscience Lett., Elsevier, Vol. 464, No. 1, pp. 26–28, 2009.

DiX C (or Parylene-C) has been widely used as a coating material to insulate neural electrodes in recent decades. However, its uses are limited due to its extremely low adhesiveness with neuronal cells. Other functional materials in the diX family, such as diX A, diX AM, and diX H, have been commercialized recently and would offer different features in biocompatibility from diX C. However, their cell adhesiveness remains unknown. In this work, we used an *in vitro* approach to investigate how the surface of each material in the diX family affects the degree of neuronal cell adhesiveness compared with a conventional culture dish of polystyrene (PS). The neuronal cell adhesiveness on diX AM and diX H was almost equivalent to that for the PS dish, whereas neuronal cells did not settle on the surface of diX C and diX A. Our results suggest that diX AM and diX H could provide another practical feature: they could act as a coating material for a scaffold in a substrate with any configuration in neural devices.