Regularized level-set-based inverse lithography algorithm for IC mask synthesis

用于集成电路掩模综合的基于水平集的 正则化反向光刻算法

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- Optical proximity correction optimization methods can be divided into two classes: rule-based approaches and modelbased approaches. In advanced technology nodes, rule-based approaches do not work well; in contrast, inverse lithography technology (ILT), as a special case of model-based approaches, produces a much better result
- The level-set-based inverse lithography technology (LSB-ILT) represents the mask as a 2D level-set function and the representation allows contours to merge, break, appear, or disappear, in a consistent, mathematical representation
- The manufacturability of the optimized mask is one of the critical issues in ILT. Considering that few studies were concerned about enhancing the manufacturability of the mask generated by LSB-ILT, it is necessary to reduce the complexity of the mask in the LSB-ILT optimization process

 This paper presents a regularized level-set-based inverse lithography algorithm with high pattern fidelity in partially coherent illumination, which has the advantage of reducing mask complexity in the optimization process



Fig. 4 Overall flow of regularized level-set based ILT

Group	Test target	Initial cost	Final cost	arepsilon metric ^a	ε metric ^b	ε metric ^c	Rate $\eta^{ m b}$ (%)	Rate η^{c} (%)
SLP	SGL1 [*]	6648	2598±5	252	138	170	45.24	32.54
	SGL2 [*]	5891	3088 ± 5	292	142	161	51.40	44.86
	NOR2*	9596	3799±5	298	216	238	27.51	20.13
	OR1	7039	4229±5	186	122	145	34.41	22.04
	INV0	6675	3519 ± 5	168	93	101	44.64	39.88
MLP	AND2V	11 978	4596±5	588	323	350	45.07	40.48
	NAND2H	16 091	5994 ± 5	527	378	418	28.27	20.68
	NOR3	11 881	5199 ± 5	794	410	451	48.36	43.20
	OR2H	10 670	5249 ± 5	496	340	372	31.45	25.00
	OR2V	10 776	5399 ± 5	658	360	400	45.29	39.21
LLP	NOR4H	39 740	13 397 \pm 5	3733	1885	2317	49.50	37.93
	AND4H	42 839	14 494 \pm 5	4233	2737	2918	35.34	31.07
	DQ4V	37 882	12 779 \pm 5	2599	1620	1806	37.67	30.51
	NAND4V	39 823	13 417 \pm 5	3385	1951	2099	42.36	37.99
	OR4H	42 473	14 318 \pm 5	3645	1835	2039	49.66	44.06

Table 1 Performance comparison between the ordinary LSB-ILT algorithm and the RLSB-ILTalgorithm with the Laplacian term or TV term

The first three patterns with '*' are the 36 nm layout pattern. ^a Using the ordinary LSB-ILT algorithm; ^b using the RLSB-ILT algorithm with the Laplacian regularization function; ^c using the RLSB-ILT algorithm with the TV regularization function



Fig. 7 Comparison of the simulation time of 15 test patterns between the ordinary LSB-ILT algorithm and the RLSB-ILT algorithm with the Laplacian term or TV term