The Effects of Preheating Millisecond Anneals on Dopant Activation in Silicon

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Fig. 4. The square of the correlation coefficients (R^2) for linear fits of the maximum carrier concentrations (N) to effective times, t_{eff}. R^2 is shown for the fits to t_{eff} calculated in each of the four heating stages shown in Fig.1 (PH, FH, FC and SC) and for the whole anneal between 0.5 and 6eV. The analysis highlights differences in the factors that affect the carrier activation in the four implant types (As1, As3, P1 and P3). The figure also includes R^2 for

TABLE II. COMPARISON OF THE CHARACTERISTICS OF THE ANNEALS USED TO EXPLORE THE EFFECT OF PREHEATING. t_{eff} WAS CALCULATED FOR $E_A=1.9eV$ IN THE SLOW COOLING STAGE. d_{reg} WAS CALCULATED FOR THE PREHEAT/RAMP-UP STAGES

Recipe	As1			As3			P1			P3		
	T_{peak} (°C)	t_{eff} (s)	d_{reg} (nm)	T_{peak} (°C)	t_{eff} (s)	d_{reg} (nm)	T_{peak} (°C)	t_{eff} (s)	d_{reg} (nm)	T_{peak} (°C)	t_{eff} (s)	d_{reg} (nm)
NPMSA	1175.0	4.1	19	1176.8	4.0	19	1176.3	4.0	19	1182.4	4.1	19
PSMSA	1173.3	4.0	105	1167.7	4.0	105	1173.9	4.0	105	1168.3	4.0	105
BSH	800.6	3.7	36	800.1	3.7	33	801.1	3.8	33	801.4	3.8	34
Spike	801.5	3.8	204	801.4	3.8	203	-	-	-	-	-	-
HTIMSA	1177.0	7.7	88	1177.4	7.8	90	1178.8	7.9	90	1169.1	7.7	90

Table II also includes data for the high-T MSA (HTIMSA). This case was included for comparison here, because of all the recipes in Table I, HTIMSA gave the lowest N_A. This might be expected from the greater deactivation expected from a higher T_{post} but the preheating