## **Commercial Wafer Specifications**

Here are the specification for Si wafers from one of the worlds top companies, Wacker Siltronic, as they appear in the Internet in Nov. 2000.

- **Notice:** Concentrations here are in **cm<sup>-3</sup>**. The conversion to **part per milion (ppm)** is simple:orrelation
- The atomic density of Si is **4.96 · 10<sup>22</sup> cm<sup>-3</sup> or about 5 · 10<sup>22</sup> cm<sup>-3</sup>.** This gives us

$$1 \text{ ppm} = 5 \cdot 10^{16} \text{ cm}^{-3}$$

The lowest concentration given in the table (look for it) is  $5 \cdot 10^{10} \text{ cm}^{-3}$ ; it corresponds to 1 ppt or  $10^{-12}$ .

Surface concentrations [S] (given in cm<sup>-2</sup>) are <u>converted to volume concentrations</u> [V] by

With *a* = lattice constant (= 0,5431 nm) or, more precise for single crystals, distance between the crystallographic planes. With *a* approximately 0,5 nm = 5 · 10<sup>-8</sup> cm, we have
 [V] = 5 · 10<sup>16</sup> cm<sup>-3</sup> = 1 ppm corresponds to S = 10<sup>8</sup> cm<sup>-2</sup>

Many specifications relate to the "flatness" of the wafers and the perfection of the surface; the abbreviations used are

*LLS* (sometimes also abbreviated LPDs): Localized Light Scattering Defect; this relates to a detection method of sub-µm size surface imperfections (resulting from bulk microdefects) *SFQR* : Site flatness quality requirements (??): Whatever it means in detail - definitely a measure of flatness in a region comparable to the size of a single chip.

(The rest: Who knows - to be included later)

Crystal / Bulk				300mm			200mm			150mm		125mm	100mm
Growth Technique *)	owth Technique *)			CZ			CZ			CZ		CZ	CZ
Orientation			1-0-0			1-0-0			1-0-0 / 1-1-1			1-0-0 / 1-1-1	1-0-0/1-1-1
Orientation Tolerance	degree		± 0.2			± 0.2			± 0.5			± 0.5	± 0.5
Off Orientation		degree	0		0 - 4		0 - 4			0 - 4	0 - 4		
Dopant			Boron / Phosphorus			Boron / Phosphorus			Boron / Phosphorus			Boron / Phosphorus	Boron / Phosphorus
Resistivity Target Range	pol prime - Boron	Ohmcm	0.5 - 50			0.5 - 50			0.5 - 50			0.5 - 50	0.5 - 50
	pol prime - Phosphorous	Ohmcm	1.0 - 50			1.0 - 50			1.0 - 50			1.0 - 50	1.0 - 50
	epi substrate - Boron	Ohmcm	0.006 - 50			0.006 - 50			0.006 - 50			0.006 - 50	0.006 - 50
Radial Resistivity Variation	Boron typical 1-0-0 / 1-1-1	%	< 10			< 5			< 5 / < 6			< 6 / < 10	< 8 / < 9
	Phosph. typical 1-0-0 / 1-1-1	%	< 15			< 15			< 12 / < 25			< 12 / < 25	< 15 / < 25
Oxygen Target Range ± Tol.	pol prime - Boron 1-0-0		4.8 - 7.8 x 10 <sup>10</sup> ± 0.5			5 - 7.8 x 10" ± 0.5			5.8 - 8.9 x 10" (± 0.6 - 0.8)			5.8 - 8.9 x 10" (± 0.5 - 1.0)	5.8 - 8.9 x 10 <sup>17</sup> (± 0.8 - 1.1
	1-1-1	at cm <sup>3</sup>	NA			NA			5.8 - 8.9 x 10 <sup>17</sup> (± 0.7 - 1.0)			6.2 - 8.9 x 10" (± 0.5 - 1.0)	5.9 - 8.9 x 10" (± 0.8 - 1.5
	pol prime - Phosph. 1-0-0	ASTM F121-83	4.8 - 7.8 x 10 <sup>13</sup> ± 0.5			6 - 7.5 x 10 <sup>11</sup> ± 0.5			5.8 - 8.9 x 10" (± 0.6 - 0.8)			5.8 - 8.9 x 10 <sup>17</sup> (± 0.5 - 1.0)	5.8 - 8.9 x 10 <sup>17</sup> (± 0.8 - 1.2
	1-1-1		NA			NA			5.8 - 8.9 x 10 <sup>1</sup> (± 0.7 - 1.0)			6.2 - 8.9 x 10" (± 0.5 - 1.0)	5.9 - 8.9 x 10" (± 0.8 - 1.5
Radial Oxygen Variation	typical %		< 10			< 5			< 6			< 6	< 5 - 10
Bulk Metal Concentration	Fe	at cm <sup>-3</sup>	≤ 5.0 x 10 <sup>10</sup>		≤ 5.0 x 10 <sup>10</sup>		≤ 1.0 x 10"			≤ 1.0 x 10 <sup>11</sup>	≤ 1.0 x 10 <sup>11</sup>		
Bulk Carbon Concentration	measured on wafer			≤ 2.0 x 10 <sup>16</sup>			≤ 2.0 x 10 <sup>16</sup>		≤ 2.0 x 10 <sup>9</sup>				
	meddarod on March	at ciri	I	52.0 x 10	•		≤ 2.0 x 10"	6		≤ 2.0 x 10"		≤ 2.5 x 10 <sup>16</sup>	≤ 2.5 x 10 <sup>16</sup>
Deliched Wofers / Substrates		atem			•			8					
Polished Wafers / Substrates			1	300mm			200mm			150mm		125mm	100mm
Polished Wafers / Substrates Surface Metals	Cu / Cr / Fe / Ni	at cm²		<b>300mm</b> ≤ 1.0 x 10 <sup>10</sup>	1		<b>200mm</b> ≤ 2.5 x 10 <sup>10</sup>	٥		<b>150mm</b> ≤ 5.0 x 10 <sup>∞</sup>	1	<b>125mm</b> ≤ 5.0 × 10 <sup>10</sup>	<b>100mm</b> ≤ 5.0 × 10 <sup>10</sup>
	Cu / Cr / Fe / Ni Al / Zn / K / Na / Ca	at cm² at cm²	- 0.2	300mm ≤ 1.0 x 10 <sup>10</sup> ≤ 5.0 x 10 <sup>10</sup>			<b>200mm</b> ≤ 2.5 × 10 <sup>10</sup> ≤ 1.0 × 10 <sup>10</sup>	0		<b>150mm</b> ≤ 5.0 × 10 <sup>it</sup> ≤ 2.0 × 10 <sup>it</sup>		<b>125mm</b> ≤ 5.0 x 10 <sup>∞</sup> ≤ 2.0 x 10 <sup>11</sup>	<b>100mm</b> ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup>
	Cu / Cr / Fe / Ni A/ Zn / K / Na / Ca size	at cm² at cm² µm	> 0.2	300mm ≤ 1.0 x 10 <sup>s0</sup> ≤ 5.0 x 10 <sup>s0</sup> > 0.16	× 0.12	> 0.2	200mm ≤ 2.5 x 10" ≤ 1.0 x 10" > 0.16		> 0.3	<b>150mm</b> ≤ 5.0 × 10 <sup>st</sup> ≤ 2.0 × 10 <sup>st</sup> > <b>0.2</b>	> 0.12	$125mm \\ \leq 5.0 \times 10^{10} \\ \leq 2.0 \times 10^{11} \\ > 0.3$	<b>100mm</b> ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > <b>0.3</b>
	Cu / Cr / Fe / Ni Al / Zn / K / Na / Ca size pol prime	at cm² at cm² µm # per wafer	< 30	<b>300mm</b> ≤ 1.0 x 10 <sup>30</sup> ≤ 5.0 x 10 <sup>30</sup> > <b>0.16</b> < 40-300	> 0.12 < 200-10 <sup>3</sup>	> 0.2 < 15-35	<b>200mm</b> ≤ 2.5 × 10 <sup>°°</sup> ≤ 1.0 × 10 <sup>°°</sup> > <b>0.16</b> < 20-120	> 0.12 < 70-600	> <b>0.3</b> < 15	<b>150mm</b> ≤ 5.0 × 10 <sup>14</sup> ≤ 2.0 × 10 <sup>14</sup> > <b>0.2</b> < 30	> 0.12 NA	$125mm$ $\leq 5.0 \times 10^{10}$ $\leq 2.0 \times 10^{11}$ $> 0.3$ $< 15$	<b>100mm</b> ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>10</sup> > <b>0.3</b> < 15
Surface Metals	Cu / Cr / Fe / Ni A / Zn / K / Na / Ca size pol prime UtraFlat (150 mm)	at cm² at cm² µm # per wafer # per wafer	< 30 NA	300mm ≤ 1.0 x 10 <sup>33</sup> ≤ 5.0 x 10 <sup>30</sup> > 0.16 < 40-300 NA	> 0.12 < 200-10 <sup>5</sup> NA	> 0.2 < 15-35 NA	200mm ≤ 2.5 × 10° ≤ 1.0 × 10° > 0.16 < 20-120 NA	> 0.12 < 70-600 NA	> 0.3 < 15 < 5	150mm       ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > 0.2       < 30	> 0.12 NA < 150	125mm ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > 0.3 < 15 NA	100mm           ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > 0.3           < 15
Surface Metals LLSs (Frontside) *)	Cu / Cr / Fe / Ni Al / Zn / K / Na / Ca size pol prime	at cm² at cm² µm # per wafer # per wafer # per wafer	< 30	300mm ≤ 1.0 x 10 <sup>10</sup> ≤ 5.0 x 10 <sup>10</sup> > 0.16 < 40-300 NA < 60	> 0.12 < 200-10 <sup>3</sup>	> 0.2 < 15-35	200mm ≤ 2.5 × 10 <sup>°</sup> ≤ 1.0 × 10 <sup>°</sup> > 0.16 < 20-120 NA < 20-65	> 0.12 < 70-600	> <b>0.3</b> < 15	<b>150mm</b> ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > 0.2 < 30 < 10 NA	> 0.12 NA	125mm ≤ 5.0 × 10 <sup>m</sup> ≤ 2.0 × 10 <sup>m</sup> > 0.3 < 15 NA NA	100mm ≤ 5.0 × 10 <sup>th</sup> ≤ 2.0 × 10 <sup>th</sup> > 0.3 < 15 NA NA
Surface Metals LLSs (Frontside) *) Diameter Tolerance	Cu / Cr / Fo / Ni Al / Zn / K / Na / Ca size pol prime Ultra/Flat (150 mm) monitor	at cm² at cm² µm # per wafer # per wafer mm	< 30 NA	300mm ≤ 1.0 x 10 <sup>33</sup> ≤ 5.0 x 10 <sup>33</sup> > 0.16 < 40-300 NA < 60 ± 0.2	> 0.12 < 200-10 <sup>5</sup> NA	> 0.2 < 15-35 NA	<b>200mm</b> $\leq 2.5 \times 10^{\circ}$ $\leq 1.0 \times 10^{\circ}$ > 0.16 < 20-120 NA < 20-65 $\pm 0.2$	> 0.12 < 70-600 NA	> 0.3 < 15 < 5	$\begin{array}{c} \textbf{150mm} \\ \leq 5.0 \times 10^{10} \\ \leq 2.0 \times 10^{11} \\ \textbf{> 0.2} \\ < 30 \\ < 10 \\ \textbf{NA} \\ \pm 0.2 \end{array}$	> 0.12 NA < 150	125mm ≤ 5.0 × 10° ≤ 2.0 × 10'' > 0.3 < 15 NA NA ± 0.2	100mm ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > 0.3 < 15 NA ± 0.2
Surface Metals LLSs (Frontside) ') Diameter Tolerance Warp	Cu / Cr / Fe / Ni Al / Zn / K / Na / Ca size pol prime UltraFlat (150 mm) monitor polished - without layer	at cm² at cm² µm # per wafer # per wafer mm µm	< 30 NA	300mm ≤ 1.0 × 10 <sup>33</sup> ≤ 5.0 × 10 <sup>33</sup> > 0.16 < 40-300 NA < 60 ± 0.2 < 50	> 0.12 < 200-10 <sup>5</sup> NA	> 0.2 < 15-35 NA	200mm ≤ 2.5 × 10" ≤ 1.0 × 10" > 0.16 < 20-120 NA < 20-65 ± 0.2 < 20	> 0.12 < 70-600 NA	> 0.3 < 15 < 5 NA	$\begin{array}{r llllllllllllllllllllllllllllllllllll$	> 0.12 NA < 150 NA	$\begin{array}{c} 125mm \\ \leq 5.0 \times 10^{10} \\ \leq 2.0 \times 10^{11} \\ > 0.3 \\ < 15 \\ NA \\ NA \\ \pm 0.2 \\ < 30 \end{array}$	100mm ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > 0.3 < 15 NA NA ± 0.2 < 30
Surface Metals LLSs (Frontside) ") Diameter Tolerance Warp Wafer / Substrate Thickness	Cu / Cr / Fo / Ni Al / Zn / K / Na / Ca size pol prime Ultra/Flat (150 mm) monitor	at cm² at cm² µm # per wafer # per wafer mm µm µm	< 30 NA	300mm ≤ 1.0 x 10 <sup>10</sup> ≤ 5.0 x 10 <sup>10</sup> > 0.16 < 40-300 NA < 60 ± 0.2 < 50 775	> 0.12 < 200-10 <sup>5</sup> NA	> 0.2 < 15-35 NA	200mm ≤ 2.5 x 10" ≤ 1.0 x 10" > 0.16 < 20-120 NA < 20-65 ± 0.2 < 20 725	> 0.12 < 70-600 NA	> 0.3 < 15 < 5 NA	150mm           ≤ 5.0 × 10 <sup>st</sup> ≤ 2.0 × 10 <sup>st</sup> > 0.2           < 30	> 0.12 NA < 150 NA	125mm ≤ 5.0 × 10 <sup>a</sup> ≤ 2.0 × 10 <sup>a</sup> < 15 NA × 15 NA ± 0.2 < 30 336 / 525 / 625	100mm ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > 0.3 < 15 NA ± 0.2 < 30 300 / 375 / 525
Surface Metals LLSs (Frontside) ") Diameter Tolerance Warp Wafer / Substrate Thickness Tolerance	Cu / Cr / Fe / Ni Al / Zn / K / Na / Ca size pol prime UltraFlat (150 mm) monitor polished - without layer	at cm <sup>2</sup> at cm <sup>2</sup> µm # per wafer # per wafer mm µm µm µm µm	< 30 NA	300mm ≤ 1.0 x 10 <sup>ss</sup> ≤ 5.0 x 10 <sup>ss</sup> > 0.16 < 40-300 NA < 60 ± 0.2 < 50 775 ± 25	> 0.12 < 200-10 <sup>5</sup> NA	> 0.2 < 15-35 NA	200mm ≤ 2.5 × 10" ≤ 1.0 × 10" > 0.16 < 20-120 NA < 20-65 ± 0.2 < 20 725 ± 15	> 0.12 < 70-600 NA	> 0.3 < 15 < 5 NA 375	$\begin{array}{r llllllllllllllllllllllllllllllllllll$	> 0.12 NA < 150 NA / 675	125mm ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > 0.3 < 15 NA ± 0.2 < 30 375 / 525 / 625 ± 15	$\begin{array}{c} 100mm \\ \leq 5.0 \times 10^{10} \\ \leq 2.0 \times 10^{11} \\ > 0.3 \\ < 15 \\ NA \\ A \\ 0.2 \\ < 30 \\ 300 / 375 / 525 \\ \pm 15 \end{array}$
Surface Metals LLSs (Frontside) ") Diameter Tolerance Warp Wafer / Substrate Thickness Thickness Tolerance GBIR = TTV (Sid   <i>UtraFlaq</i> ") GBIR = Ttv (Sid   <i>UtraFlaq</i> ")	Cu / Cr / Fe / Ni Al / Zn / K / Na / Ca size pol prime UltraFlat (150 mm) monitor polished - without layer	at cm² at cm² µm # per wafer # per wafer mm µm µm µm µm µm	< 30 NA	300mm ≤ 1.0 x 10 <sup>33</sup> ≤ 5.0 x 10 <sup>33</sup> > 0.16 < 40-300 NA < 60 ± 0.2 < 50 7775 ± 25 < 4	> 0.12 < 200-10 <sup>5</sup> NA	> 0.2 < 15-35 NA	200mm ≤ 2.5 x 10" ≤ 1.0 x 10" > 0.16 < 20-120 NA < 20-62 ± 0.2 < 20 725 ± 15 < 3.5	> 0.12 < 70-600 NA	> 0.3 < 15 < 5 NA 375 < 5.0	150mm           ≤ 5.0 × 10 <sup>st</sup> ≤ 2.0 × 10 <sup>st</sup> > 0.2           < 30	> 0.12 NA < 150 NA / 675 < 2.5	$\begin{array}{c} 125 mm \\ \leq 5.0 \times 10^{\circ} \\ \leq 2.0 \times 10^{\circ} \\ > 0.3 \\ < 15 \\ NA \\ \pm 0.2 \\ < 30 \\ 375 / 525 / 625 \\ \pm 15 \\ < 6.0 \end{array}$	100mm           ≤ 5.0 × 10 <sup>10</sup> ≤ 2.0 × 10 <sup>11</sup> > 0.3           < 15
Surface Metals LLSs (Frontside) ') Diameter Tolerance Warp Warfor / Substrate Thickness Thickness Tolerance GBIR = TTV (Std   UtraFiad ') GFLR = TIR (Std   UtraFiad ')	Cu / Cr / Fo / Ni Al / Zn / K / Na / Ca size pol prime UltraFlat (150 mm) monitor polished - without layer Standards	at cm² at cm² µm # per wafer # per wafer mm µm µm µm µm µm µm	< 30 NA	300mm ≤ 1.0 x 10 <sup>∞</sup> ≤ 5.0 x 10 <sup>∞</sup> ≤ 5.0 x 10 <sup>∞</sup> < 40-300 NA < 60 ± 0.2 < 50 775 ± 25 < 4 NA	> 0.12 < 200-10 <sup>5</sup> NA	> 0.2 < 15-35 NA	200mm ≤ 2.5 × 10° ≤ 1.0 × 10° > 0.16 < 20-120 NA < 20-65 ± 0.2 < 20 725 ± 15 < 3.5 < 2.0	> 0.12 < 70-600 NA	> 0.3 < 15 < 5 NA 375 < 5.0 < 2.0	150mm           ≤ 5.0 × 10 <sup>st</sup> ≤ 2.0 × 10 <sup>st</sup> > 0.2           < 30	> 0.12 NA < 150 NA / 675 < 2.5 < 1.2	$\begin{array}{c} 125mm \\ \leq 5.0 \times 10^{\circ} \\ \leq 2.0 \times 10^{\circ} \\ > 0.3 \\ < 15 \\ NA \\ \pm 0.2 \\ < 30 \\ 375/525/625 \\ \pm 15 \\ < 5.0 \\ < 2.0 \end{array}$	100mm           ≤ 5.0 × 10°           ≤ 2.0 × 10°           < 0.3
Surface Metals LLSs (Frontside) ") Diameter Tolerance Warp Wafar / Substrate Thickness Thickness Tolerance GBIR = TTV (Std   UttraFlag ') GFLR = TTV (Std   UttraFlag ') Local Flattess ")	Cu / Cr / Fe / Ni A / Zn / K / Na / Ca size pol prime UltraFlat (150 mm) monitor polished - without layer Standards SFQR / STIRmax, s.b.f.	at cm <sup>2</sup> at cm <sup>2</sup> µm # per wafer # per wafer mm µm µm µm µm µm µm µm	< 30 NA	300mm ≤ 1.0 x 10 <sup>33</sup> ≤ 5.0 x 10 <sup>33</sup> > 0.16 < 40-300 NA < 60 ± 0.2 < 50 775 ± 25 < 4 NA < 0.25	> 0.12 < 200-10 <sup>5</sup> NA	> 0.2 < 15-35 NA	$\begin{array}{c} \textbf{200mm} \\ \leq 2.5 \times 10^{\circ} \\ \leq 1.0 \times 10^{\circ} \\ > \textbf{0.16} \\ < 20.120 \\ NA \\ < 20.65 \\ \pm 0.2 \\ < 20.65 \\ \pm 10.2 \\ < 2.0 \\ \hline \\ < 2.0 \\ < 2.0 \\ < 2.0 \\ < 0.25 \end{array}$	> 0.12 < 70-600 NA	> 0.3 < 15 < 5 NA 375 < 5.0 < 2.0 < 0.5	150mm           ≤ 5.0 × 10 <sup>st</sup> ≤ 2.0 × 10 <sup>st</sup> > 0.2           < 30	> 0.12 NA < 150 NA / 675 < 2.5 < 1.2 < 0.3	125mm           ≤ 5.0 × 10 <sup>m</sup> ≤ 2.0 × 10 <sup>m</sup> > 0.3           < 15	$\begin{array}{c} 100mm \\ \leq 5.0 \times 10^{10} \\ \leq 2.0 \times 10^{11} \\ > 0.3 \\ < 15 \\ NA \\ A \\ 0.2 \\ < 30 \\ 300 / 375 / 525 \\ \pm 15 \\ < 5.0 \\ < 2.0 \\ NA \end{array}$
Surface Metals LLSs (Frontside) ') Diameter Tolerance Warp Warfor / Substrate Thickness Thickness Tolerance GBIR = TTV (Std   UtraFiad ') GFLR = TIR (Std   UtraFiad ')	Cu / Cr / Fo / Ni Al / Zn / K / Na / Ca size pol prime UltraFlat (150 mm) monitor polished - without layer Standards	at cm² at cm² µm # per wafer # per wafer mm µm µm µm µm µm µm	< 30 NA	300mm ≤ 1.0 x 10 <sup>∞</sup> ≤ 5.0 x 10 <sup>∞</sup> ≤ 5.0 x 10 <sup>∞</sup> < 40-300 NA < 60 ± 0.2 < 50 775 ± 25 < 4 NA	> 0.12 < 200-10 <sup>5</sup> NA	> 0.2 < 15-35 NA	200mm ≤ 2.5 × 10° ≤ 1.0 × 10° > 0.16 < 20-120 NA < 20-65 ± 0.2 < 20 725 ± 15 < 3.5 < 2.0	> 0.12 < 70-600 NA	> 0.3 < 15 < 5 NA 375 < 5.0 < 2.0	150mm           ≤ 5.0 × 10 <sup>st</sup> ≤ 2.0 × 10 <sup>st</sup> > 0.2           < 30	> 0.12 NA < 150 NA / 675 < 2.5 < 1.2	$\begin{array}{c} 125mm \\ \leq 5.0 \times 10^{\circ} \\ \leq 2.0 \times 10^{\circ} \\ > 0.3 \\ < 15 \\ NA \\ \pm 0.2 \\ < 30 \\ 375/525/625 \\ \pm 15 \\ < 5.0 \\ < 2.0 \end{array}$	$\begin{array}{c} 100mm \\ \leq 5.0 \times 10^{10} \\ \leq 2.0 \times 10^{11} \\ > 0.3 \\ < 15 \\ NA \\ \pm 0.2 \\ < 30 \\ 300' 375 / 525 \\ \pm 15 \\ < 5.0 \\ < 2.0 \end{array}$