

# RENAISSANCE RESEARCH GROUP

**CREE RESEARCH, INC.** (CREE - OTC)

Rating: Buy

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**Stock Price (5/14/98):** \$16.875  
**Shares Outstanding:** 13.636 million  
**Fiscal Year End:** June

<b>Earnings Per Share:</b>	<b><u>1996A</u></b>	<b><u>1997A*</u></b>	<b><u>1998E</u></b>	<b><u>1999E</u></b>
Q1 (Sept):	N/A	\$0.15*	\$0.09A	U/R
Q2 (Dec.):	N/A	\$0.03	\$0.11A	U/R
Q3 (March):	N/A	\$0.04	\$0.13A	U/R
Q4 (June):	<u>N/A</u>	<u>\$0.06</u>	<u>\$0.14</u>	<u>U/R</u>
<b>Full-Year EPS</b>	(\$0.09)	\$0.27	\$0.47	\$0.70
<b>P/E Multiple:</b>	NMF	62.5x	35.9x	24.1x

\* Core operating earnings per share for 1Q97 and 2Q97 are (\$0.04) and \$0.03, respectively; quarterly estimates may not sum to annual EPS estimates due to the weighted-average share base calculation. 1997E & 1998E use 10% & 36% tax rate, respectively.

## Reasons for Recommendation:

- ◇ Cree announced March 12<sup>th</sup> that it has demonstrated a SiC metal-semiconductor field-effect transistor (MESFET) with 53 watts of output under continuous wave operation at a frequency of 3.0 Ghz. This was achieved from a single chip with a die area of only 3 square millimeters. We believe this milestone achievement marks a turning point in Cree's business going forward, now that the company can begin to prototype SiC MESFETs for applications in wireless base stations and broadcast systems, where eventually they may replace — with either fewer or one single chip — the many GaAs chips currently strung together to generate similar (wattage) output.
- ◇ We find Cree's valuation compelling with a PEG ratio (P/E to Growth rate) of 0.5, and there is upside to our estimates. We believe the company is building an important franchise in the SiC semiconductor material business and should be viewed as having a business model similar to Vitesse Semiconductor going forward — but with a larger set of technology applications and a larger addressable market. *See more next page under Additional Comments.*

## Company Description:

North Carolina based Cree Research, Inc. is the world leader in the development of silicon carbide based semiconductors, which have advantages in certain optoelectronic, power, high temperature, RF and microwave applications. Cree owns outright or licenses exclusively 42 patents related to its process and device technology.

## *Business perspective on Telecommunications Equipment and related Technology Investments*

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## **BIGGER PICTURE:**

At seventeen dollars per share, Cree Research is selling for twenty-four times our earnings estimate for the fiscal year ended June 1999, which earnings are generated by an evolving number of products, currently including SiC/GaN chips for bright blue LEDs used for signage and instrumentation, SiC semiconductor wafers and SiC crystal. Cree's base product is Silicon Carbide (SiC semiconductor) wafers, which offer the highest electron mobility (of any silicon-based semiconductor material) on the market, and for which they maintain a comprehensive patent estate. Asea Brown Boveri, Motorola, Siemens, Westinghouse and Philips are interested in SiC because electrons can accelerate very rapidly through the material, offering better power/performance characteristics for applications in microwave power amplifiers, smaller and more power-efficient high-frequency transistors and transmitters used for radar and radio broadcast systems, wireless-phone base stations, satellite communications systems and HDTV broadcast equipment, plus SiC-based resistors for industrial electric motors and blue laser diodes enabling high-density optical storage systems. The addressable market for each of these applications, for which Cree has developed a cornerstone enabling technology, ranges from the hundreds of millions of dollars to several billion dollars. We believe that Cree can achieve over a billion dollars in sales in five to seven years and gain a multiple of that in market valuation, based on comparisons with similar companies. Cree's total market value at current prices is \$232 million.

## **Additional Comments:**

- ◇ We want to emphasize on the heels of Cree's March 12<sup>th</sup> announcement regarding a 53-watt MESFET that the company will now begin to prototype transistors for customers, but that Cree lacks the capacity to produce these die (chips) in volume. The company's new plant allows room to grow capacity for producing various transistor die, and we believe Cree will begin to define its plans to do so over the next six months. The company has targeted additional milestones for achieving higher wattage outputs. Additionally, on March 23<sup>rd</sup> Cree announced that Siemens A.G. has authorized deliveries of its improved LED die utilizing a conductive buffer layer under the parties' supply agreement. The new version, designated the CB 290, is simpler and therefore less expensive to manufacture yet approximately 50% brighter than its current product which the CB290 should fully replace by June, 1998. This will allow Cree to maintain or expand product margins while reducing prices to drive increased market penetration, with the eventual goal being \$0.05 or less for volume shipments. (March 26, 1998)
- ◇ We spoke with management this morning and are fine-tuning our FYE 1998 3Q and 4Q estimates to \$0.13 and \$0.15, respectively (versus the prior \$0.12 and \$0.16). Our single point FYE 1998 estimate remains \$0.48, for which we have high confidence and which we believe has upside. Management has offered, as early guidance, a single point number which is slightly higher than our FYE (June) 1999 estimate of \$0.70. We will begin to model quarterly estimates for the 1999 Fiscal Year after Cree reports the March quarter. (March 9, 1998)
- ◇ We are reducing our 3Q and 4Q estimates to \$0.12 and \$0.16, respectively, which brings them in line with the rest of the Street. This is a function of our building a buffer for Cree's Asian exposure and moving our modeled ramp in material sales one quarter out, and it does not diminish our enthusiasm for Cree. (February 10, 1998)
- ◇ 2Q (Dec.) FYE 1998 earnings: Cree reported record quarterly earnings of \$0.11, excluding one-time license fees, for the 2Q FYE 1998 ended December, meeting our estimate. Gross margins improved to 35.2% versus 30.7% the prior quarter on roughly flat sequential sales, due primarily to higher SiC wafer and crystal sales. Cree's balance sheet remains strong, having added \$2.4 million to working capital during the quarter. The company continues to finance its expansion from internally-generated funds. Random Notes from 2Q conference call: Cree has a stated goal of growing 3" SiC crystal by July, 1998 for moissanite sales to C3, Inc. These 3" crystals eventually will be used to manufacture 3" SiC wafers, which will reduce the unit cost of manufacturing die for transistors. Cree has a customer contract to develop for production Metal Semiconductor Field Effect Transistors (MSFETs) for microwave transmitter applications, targeting a December, 1998 time frame for the first ship-date. *This anticipated first ship-date has been moved out six months from prior guidance (see October 20, 1997 note under "Historical Estimates").* We will begin to model this business when development work is complete and a contract is announced — but as a rough guide, we believe a \$15 million contract could generate \$6 million in pre-tax gross margin of which perhaps \$0.16 per share could drop to fully-taxed net income. As an additional line of business, Siemens is helping Cree develop pure green LEDs for an

application to reduce power consumption in stoplights. The company expects to sell these green LEDs soon — which we have not built into our earnings model. Cree targets a 25% - 33% cost reduction for all LED manufacturing by using the new conductive buffer layer in-process. (February 10, 1998)

- ◇ Cree announced a \$2.4 million SiC wafer supply agreement with Asea Brown Boveri, a customer for several years, for shipments through calendar 1998. This is a result of improving micropipe densities and Cree's efforts to move their customers away from spot purchases to longer-term contractual commitments. While not additive to our earnings model, the contract does firm up our conviction levels and smoothes the revenue stream. The contract is the largest supply agreement to date, and we expect more of these in the future. (January 8, 1998)
- ◇ Cree is currently making the transition to two-inch material for all crystal, wafer and LED production, a process we expect to take three months. We will further refine this transition time-line, for modeling purposes, after another follow-up with management in early December. Prior to that discussion, we have bumped our December quarter by \$0.01 to \$0.11 and the March and June quarters by \$0.02 each to \$0.18 and \$0.20, respectively. (November 4, 1997)
- ◇ Increasing production volumes of Cree's DH-85 "Superbright" blue LEDs (light emitting diode) are driving a dynamic earnings ramp which we expect to be enhanced by increased SiC wafer and crystal shipments later in FYE 1998. Visibility is improving for increased sales and gross margin contributions from *Real Color Displays*. We believe the valuation is cheap, based upon the growth rate and the magnitude of future business which we think Cree is poised to capture. (October 17, 1997)
- ◇ Cree's planned insertion of a two-inch wafer into the DH-85 (LED) manufacturing process is now targeted for December, three months ahead of plans discussed last quarter. We estimate that this will increase the number of die per SiC wafer by another 48%, beyond the gains resulting from die size reductions discussed on the August 4<sup>th</sup> conference call. Associated volumes, production efficiencies, margin enhancements and market penetration should flow through our model earlier than we had expected, though we plan no major adjustments to outlying estimates until Cree books the September quarter. (August 5, 1997)
- ◇ Planned migration to two-inch wafers in DH-85 (LED) manufacturing process is on the map for March of 1998 — Cree plans to show samples of a three-inch SiC wafer in six months. Power output of their microwave device was boosted from eleven to fifteen watts during the quarter. At 40w, the device qualifies for wireless base station applications, and Cree is now discussing this with potential customers. At 50w, the device qualifies for use by Westinghouse in HDTV transmitters (broadcast equipment). (May 1, 1997)
- ◇ Possibility of increased SiC semiconductor wafer shipments to Westinghouse in late calendar 1997 for HDTV applications lends upside to our FY'98 estimate. Work continues on increasing power output of microwave devices with performance advantages in radar systems and wireless carrier base stations. (April 15, 1997)
- ◇ Cree is working to add a conductive buffer layer to LED chips. Resulting manufacturing efficiencies increase die yields per wafer, allowing price reductions to drive increased market penetration — but with enhanced gross margins. (April 15, 1997)

### **Blue Laser development progressing quickly:**

Cree announced July 29, 1997 a continuous wave (CW) operation of its blue laser at room temperature, with the emission lasting more than fifteen seconds. This followed shortly after its June 19<sup>th</sup> release detailing Cree's demonstration of an electrically pulsed gallium nitride blue laser (at room temperature) with a device lifetime in excess of one hour — using their same SiC (silicon carbide) material as a substrate. This is a big deal, since management had expected it to take up to one year to progress from an electrically pulsed laser (pulsed "on" for one millisecond — 1/1000 — per second) to CW operation.

Cree's room temperature laser operation is significant, because the process of electrically inducing a material to lase creates heat which could necessitate artificial cooling in some future products (cooling equipment's bulk would limit applications for a semiconductor device in optical storage systems and consumer electronics requiring some degree of miniaturization). The heat generated by a laser is a principal cause of device failure. SiC as a substrate is a better heat sink than the sapphire substrate used by competitors Nichia and Hewlett-Packard, which we believe will allow Cree's device to offer competitive advantages in future products as this technology becomes commercialized. (*See more on Nichia below*).

Our best guess is that it will take up to two years to achieve a full duty-cycle device with a lifetime approaching 10,000 hours, at which point it is commercially viable in applications such as high-end data-warehousing optical storage systems and later, consumer products such as CD-ROM, CD-Audio and DVD.

The shorter wavelength of light emitted by a blue laser allows denser compression of data versus current generation red or infrared lasers, increasing storage capacity by four or five fold. We believe that Cree would like to joint venture this product development effort with a larger company with related expertise and channels of distribution — like a Hewlett-Packard or a Siemens. Something could develop on this front during the next nine months.

### **Regarding Nichia:**

Nichia (Japan), Cree's closest competitor in blue LEDs, uses gallium nitride on a sapphire substrate for their base chip material. Though Nichia's LEDs deliver roughly twice the candlepower (versus Cree's 650 microwatts) thereby offering more brightness for outdoor signage applications, they cost twice as much as Cree's product.

Several other facts: The more tightly aligned crystal structure of Cree's SiC material results in fewer defects. Nichia's electrodes/contacts are horizontal (versus Cree's vertical, the industry standard) which makes their lamp (LED) occupy more real estate, reducing the number of applications where miniaturization is an important issue, i.e. instrumentation. Cree's anticipated use of a conductive buffer layer in their chip-making process will increase their current size advantage — since sapphire is non-conductive, Nichia will not be able to reduce LED areage with a conductive buffer layer. Lastly, Cree sells chips and Nichia sells lamps, reducing Nichia's customers' flexibility in customizing the product.

### **Upside to our Estimates:**

Since reactors #4 and #5 were brought on line in late July (1997), management's eventual decision to order more epitaxial reactors remains a function of new customer acquisition for the company's blue LEDs. Each reactor currently requires six months of fine-tuning after delivery before qualifying for production, but if Cree's engineers are able to shorten this initial qualification period, we could see some revenue contribution in FY 1999 from additional "epi" equipment. Our 4Q (June) FYE'98 DH-85 sales volume estimates equate to full capacity utilization on current manufacturing base, but address under 2% of imputed market of 10 billion units for its "Superbright" blue LEDs. *One reactor's production for a full quarter translates into additional earnings of \$0.11 per quarter fully-taxed (at assumed yields, prices and margins during 4Q'98).*

As increasing volumes drive margin improvements affording DH-85 price reductions which enable market penetration and new customer acquisition, we expect management to order additional reactors. We reiterate that Cree could experience dramatically increased demand for SiC wafers in FY 1999, lending additional upside to our estimates. The recently enhanced likelihood of year-ahead microwave device sales into wireless transmission markets adds another dimension to Cree's business opportunity — which we will attempt to model as the year progresses.

### **Historical Earnings, Estimates & Revisions:**

- ◇ Cree reported \$0.09 for the 1Q (September) quarter, beating our estimate by \$0.01 despite a full 34% tax rate (versus the 20% we had modeled). Silicon carbide (SiC) material shipments to C3, Inc. for its artificial diamond products were roughly \$470,000 for the period, adding visibility for a new line of business which the Street will soon begin to model. Micropipe density for Cree's wafer products continues to improve, to approximately 20/sq.cm. (micropipes per square centimeter), a thirty percent improvement over the June quarter. At these (micropipe) densities, the Company's two-inch wafers qualify for transistor applications in microwave transmitters. Management discussed ongoing negotiations for a contract to deliver \$15 million to \$20 million of these Metal Semiconductor Field Effect Transistors (MSFETs) to a customer over 18 months, with a first ship-date sometime in the 4Q (June) quarter. We will begin to model this business when visibility improves. At less than 5/sq.cm., Cree's SiC material will qualify for certain microwave power applications — which we expect to be a FYE 1999 phenomenon. (October 20, 1997)
- ◇ Cree reported \$0.06 for the 4Q (June) quarter, beating our estimate by a \$0.01 despite special charges of \$255,000 for leasehold write-offs (which we expect to be the last extraordinary charges for some time). Remaining loss carry-forwards caused the company to reverse prior tax over-accruals predicated upon a projected 10% tax rate for FYE 1997, partially offsetting these write-offs. We are projecting fully taxed earnings for FYE 1998 and beyond. Operating performance was better than we had modeled, largely from blue LED and SiC wafer sales. After follow-up with management, we have added \$0.01 each to our 1Q and 2Q estimates for FYE 1998, as reflected above. We will have more

insight upon release of the 10-K August 15<sup>th</sup>, at which point we will refine our earnings model. (August 5, 1997)

- ◇ Cree announced June 25<sup>th</sup> a \$600,000 order from a Korean company for 800 of its *Real Color Modules*, for construction of a live replay board for a new sports arena. The modules are scheduled to be shipped in the upcoming September quarter. This is the first good news from Cree's *Real Color Displays* division in some time. We are modeling 20% gross margins for the business in this quarter only, giving a slight haircut to management's 25% to 30% target, which bumps our 1Q FYE'98 estimate by a penny to \$0.07. If strong orders for this product line continue, we will begin to model a positive contribution from this division for the rest of FYE 1998. Similar orders in each quarter of FYE 1998 would boost earnings for the year by \$0.04 to \$0.05. (June 25, 1997)
- ◇ Cree reported \$.04 on April 30<sup>th</sup> for the third fiscal (March) quarter, meeting our estimate despite a \$204,000 write-off, a specification change by Siemens (largest customer) to increase LED resistance to electrostatic discharge and a small loss at Real Color Displays (RCD). Contract revenues were down \$400,000 sequentially, because those with cost-sharing provisions were moved below the revenue line. The net effect boosts R&D by the amount of the previously negative contract margin, simplifying the income statement going forward and better reflecting product development expenses. Prior quarters' operating expenses will be reclassified to provide meaningful comparables. Gross margins were up due to higher average selling prices for blue LEDs related to the spec change and the improved product development accounting. LED inventories were cleaned out, which we view as a positive. Related to the spec change, our target date for insertion of conductive buffer layer (CBL) into manufacturing process is moved out one quarter, to November 1997. The Siemens contract has been re-priced (upwards) because of the "specifications change-order," allowing Cree to capture gross margin that would have been lost in the September quarter because of CBL delay. Our lowered FYE 1998 estimate reflects an expected three month delay in bringing the fourth and fifth epitaxial reactors into production. Despite this delay, we believe the process of qualifying additional reactors for production is becoming more predictable. We do not believe our lowered estimate will affect CREE's share price since we have just begun to publish. Management is determined to avoid further losses at Real Color Displays (RCD). (May 2, 1997)
- ◇ We believe sustainable transition to (operating earnings) profitability began 2Q (Dec.) reported 1/29. Now that epitaxial process has become more predictable, earnings ramp is becoming more a function of volume gains from insertion of a conductive buffer layer into the manufacturing process. New epitaxial reactors generate a pay-back on investment in less than one year. Marketing team is now in Asia working to add new customers for its DH-85 "Superbright" blue LEDs — visibility should improve shortly for new client acquisition and diversification. (April 15, 1997)
- ◇ Sales ramp of first two commercial products combined with much operating leverage on G&A and R&D can grow FY'98E in excess of 100% year-to-year. (March 4, 1997)

Other Companies Mentioned:

C3, Inc. (CTHR-OTC-\$9.75)

Hewlett-Packard Company (HWP-NYSE-\$64.75)

Motorola, Inc. (MOT-NYSE-\$56.50)

Vitesse Semiconductor Corporation (VTSS-OTC-\$46.375)

**BACKGROUND:**

**Institutional Holdings:** 3.83 million (28.1%)

**Insider Holdings:** 1.701 million (12.5%)

**Underwriting Information:** 1.6 million shares in 2/93 @ \$8.25 per share; Paulson Investment Co.

**Additional Financing:** February 1996 private placement of 1.08 million shares at \$16.875 and 300,000 warrants with an exercise price of \$27.23.

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