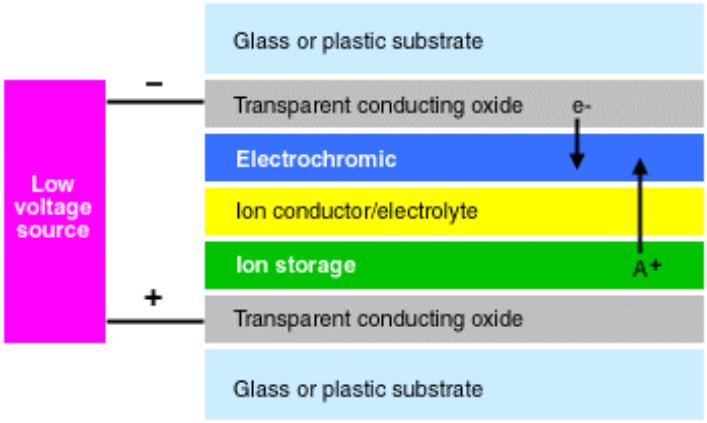
Description of the Technology:

The NREL “smart glass” integrates two concepts, photovoltaics and electrochromics to produce a self-powered, self-dimming window, skylight, eyewear, indoor signage or display. The smart windows can be incorporated into buildings (commercial and residential), vehicles (land, sea, and air), skylights, interior partitions and structures, eyewear, and indoor displays and signs.

Electrochromic windows consist of up to seven layers of materials. The essential function of the device results from the transport of hydrogen or lithium ions from an ion storage layer and through an ion conducting layer, injecting them into an electrochromic layer. The electrochromic layer is typically tungsten oxide (WO_3). The presence of the ions in the electrochromic layer changes its optical properties, causing it to absorb visible light. The large-scale result is that the window darkens. The central three layers are sandwiched between two layers of a transparent conducting oxide material. To protect the five layers of materials, they are further sandwiched between two layers of glass. All of the layers, of course, are transparent to visible light.



To darken (or "color") the windows, a voltage is applied across the two transparent conducting oxide layers. This voltage drives the ions from the ion storage layer, through the ion conducting layer and into the electrochromic layer. To reverse the process, the voltage is reversed, driving the ions in the opposite direction, out of the electrochromic layer, through the ion conducting layer, and into the ion storage layer. As the ions migrate out of the electrochromic layer, it lightens (or "bleaches"), and the window becomes transparent again.

Prototypes of the NREL smart glass for the flat glass applications have been built and tested.

The NREL smart glass allows the user to control the amount of light transmitted through the glass. The benefits of this technology range from reduced energy consumption for heating and cooling, increased control over the work environment, increased worker productivity, and increased sales and or rental revenue. A unique benefit or feature of the NREL smart glass is it is self-powering, it does not need to be connected to a buildings electrical system in order to operate.

Future products would encompass dynamic eyewear (sunglasses, prescription glasses, ski goggles, helmet visors) that react to changing environments. Airplane windows, automobile windows, train windows, ship windows that automatically dim reducing glare and heat buildup while providing privacy. Vehicles utilizing the NREL smart glass would benefit by needing smaller air conditioner compressors resulting in increased gas efficiency.

The technology is covered by the following portfolio of U.S. patents: #5,384,653, #5,377,037, #5,716,736, #5,834,137, #6,369,934, #6,441,942, and #6,420,071. There are associated foreign filings and pending patents on electrochromic components. The following link is to the electrochromic program at the Department of Energy's National Renewable Energy laboratory, http://www.nrel.gov/buildings/windows/team.html.

Market Analysis: (Size, Trends, Segments)

The worldwide flat glass market is estimated to be $40 Billion in 2004. The window market (business, residential, new, replacement) in the U.S. is estimated to be $15 Billion, $30-$45 Billion worldwide. The worldwide vehicle glass market is approximately $4 Billion, more if other vehicles are included. The worldwide sunglass and ski goggle market is estimated at $9 Billion.

Studies conducted by the U.S. Green Building Council and Rocky Mountain Institute showed that day lighting can reduce lighting energy consumption by 50-80%. Typically lighting accounts for 30-50% of the energy consumption in commercial buildings. Building owners are actively looking for ways to reduce their rising energy costs due to lighting and uneven cooling and heating. Energy savings due to day lighting and energy efficient designs and technologies reduce energy loads during peak hours resulting in significantly lowered energy costs and the ability to qualify for rebate programs. Worker productivity has been shown to increase by 6-15% by using energy-efficient building designs. Since company's spend an average of 70 times as much money per square foot per year on salaries as on energy, an increase of 1% in productivity can result in an increase to the bottom line that exceeds the company's energy bill. According to the Electric Power Research Institute, daylit buildings can result in a 10-20% increase in rental income compared to those using artificial light. Residential architectural trends towards larger, more windows, energy efficient homes are driving the demand for high end glass such as solar control glass.

Large box stores like COSTCO, Home Depot, ToysRUs, IKEA, companies like FedEx, USPO, HP are implementing daylighting to reduce their rising energy costs and to boost sales. A 1999 PG&E study comparing daylit stores to artificially lighted stores showed that daylit stores had 40% higher sales. In a 1995 Wall Street Journal article, sales were significantly higher in daylit portions of Wal-Mart stores then in portions of the store that was artificially lighted.

Higher energy efficient building codes at the federal and state levels along with the rising cost of energy and the increased trend of spending more time indoors are driving the markets for energy efficient technologies. Automotive designers are incorporating more glass into vehicles due to the rising amount of time individuals spend in their vehicles. For example the new Nissan Quest mini van has five "syklights". The NREL smart glass can provide automotive designers with a technology that can meet all of their needs: self dimming for privacy reduced solar gain resulting in higher fuel efficiency (downsize the AC system), and is self powering further reducing the demand on the vehicle's electrical system.