THERMISTOR CONDUCTION MODEL

Conduction model

Many NTC thermistors are made from a pressed disc or cast chip of a semiconductor such as a sintered metal oxide. They work because raising the temperature of a semiconductor increases the number of electrons able to move about and carry charge - it promotes them into the *conducting band*. The more charge carriers that are available, the more current a material can conduct. This is described in the formula:

$$I = n \cdot A \cdot v \cdot e$$

I = electric current (ampere)

n = density of charge carriers (count/m^3)

A = cross-sectional area of the material (m^2)

v = velocity of charge carriers (m/s)

e = charge of an electron ($e = 1.602 \times 10^{-19}$ coulomb)

The current is measured using an ammeter. Over large changes in temperature, calibration is necessary. Over small changes in temperature, if the right semiconductor is used, the resistance of the material is linearly proportional to the temperature. There are many different semiconducting thermistors sizes ranging from about 0.01 kelvin to 2,000 kelvins (-273.14°C to 1,700°C).

Most PTC thermistors are of the "switching" type, which means that their resistance rises suddenly at a certain critical temperature. The devices are made of a doped polycrystalline ceramic containing barium titanate ($BaTiO_3$) and other compounds. The dielectric constant of this ferroelectric material varies with temperature. Below the Curie point temperature, the high dielectric constant prevents the formation of potential barriers between the crystal grains, leading to a low resistance. In this region the device has a small negative temperature coefficient. At the Curie point temperature, the dielectric constant drops sufficiently to allow the formation of potential barriers at the grain boundaries, and the resistance increases sharply. At even higher temperatures, the material reverts to NTC behaviour. The equations used for modeling this behaviour were derived by W. Heywang and G. H. Jonker in the 1960s.

Another type of PTC thermistor is the polymer PTC, which is sold under brand names such as "Polyfuse", "Polyswitch" and "Multiswitch". This consists of a slice of plastic with carbon grains embedded in it. When the plastic is cool, the carbon grains are all in contact with each other, forming a conductive path through the device. When the plastic heats up, it expands, forcing the carbon grains apart, and causing the resistance of the device to rise rapidly. Like the $BaTiO_3$ thermistor, this device has a highly nonlinear resistance/temperature response and is used for switching, not for proportional temperature measurement.

Yet another type of thermistor is a **Silistor**, a thermally sensitive silicon resistor. Silistors are similarly constructed and operate on the same principles as other thermistors, but employ silicon as the semiconductive component material.

Source: http://www.juliantrubin.com/encyclopedia/electronics/thermistor.html