

# Ground-breaking innovation in humidity measurement

The making of the revolutionary  
Vaisala HUMICAP®

IE40

*The tiny HUMICAP® sensor is fabricated  
using thin film technology.*



*Yrjö Toivola was Vaisala's Managing Director from 1969 to 1991.*

Upon the death of Vilho Väisälä, Vaisala's founder, in 1969, Yrjö Toivola became Vaisala's Managing Director. He held this position until he retired in 1991.

Just like his predecessor, Yrjö Toivola had an insatiable appetite for new technology. It was not enough that new instruments were a bit better than the old ones. He also wanted to investigate fundamental issues in the field. Hence, in 1971, he commissioned a study which tried to answer the question: "Which meteorological quantity cannot be accurately measured, and which technology could provide a solution for the problem?"

The challenge was taken up by Dr. Tapio Wiik, who was working at the semiconductor laboratory at the Technical Research Center of Finland (VTT). The laboratory had been established in the mid-1960s by Professor Tor Stubb, one of the pioneers of electronic and semiconductor research in Finland.

Tapio Wiik and his colleague Tuomo Suntola decided to investigate the technologies that were used to measure relative humidity in the atmosphere. The problem was without doubt one that both meteorologists and other scientists wanted to solve. It was also a question that had bothered Vaisala since the 1930s. Although Vilho Väisälä had struggled to construct reliable hygrometers, he was never fully satisfied with the results. The Vaisala radiosondes were equipped with the so-called Frankenberg hair hygrometer, a standard type of hygrometer in which a piece of hair, approximately 28mm long and rolled several times, reacted to the changes in humidity. Therefore, Tuomo Suntola's

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task was to develop a new method for radiosonde humidity measurement that would replace the hair hygrometer.

Tapio Wiik and his research team abandoned the Frankenberg hair and searched for a completely new solution. Trusting their skills and intuition they focused on semiconductors and thin film technology. This was not an entirely new idea and several research teams around the world were simultaneously trying to construct a new type of humidity sensor. However, for one reason or another they failed. Suntola's team had to pass several obstacles before the right solution was found.

### **Beating all odds**

After two years of hard work, Tuomo Suntola, who had by now become the project manager, accomplished the task. The project resulted in the construction of five hygrometers, all of which used the revolutionary new technology. Tuomo Suntola explains: "The sensor is fabricated using thin film technology similar to that generally used in microelectronics. The lower electrical contacts are first etched on a metalized glass plate. Then a thin amorphous polymer layer is added over the electrical contacts. This results in a uniform amorphous polymer layer. The upper electrode, which must be transparent to water vapor, is then vacuum evaporated onto the polymer surface through a mechanical mask to form the active capacitor area."<sup>1</sup>

Tuomo Suntola's innovation became known as the Humicap (later HUMICAP®). It was revolutionary in many ways. First, it had no moving parts and because of the semiconductor and thin film technologies, the hygrometer was amazingly small in size. It was, of course, doubtful, how well such a new technology would operate in extreme temperatures (+40°C to -60°C) and humidity (from 0 to 100%RH), but the Humicap beat all odds. It was small, accurate and fast. According to Eero Salasmaa, Manager of the R&D Department, and Pekka Kostamo, Manager of Development Planning: "The new Humicap sensor has many attractive features – fast response, good linearity,

low hysteresis and small temperature coefficient."<sup>2</sup>

### **The skeptics became believers**

Vaisala presented the new sensor at the CIMO VI congress in Helsinki in the spring of 1973, only a few months after Tuomo Suntola's team had completed the innovation. The next opportunity came in September of the same year, when Helsinki hosted an International Technological Fair. Vaisala put the Humicap on display without much expectation. After all, Humicap represented radically new technology that was unknown for most customers. This assumption was completely false. The reaction among visitors was overwhelming. Orders began to come in during the fair and the first 50 sensors were practically torn from the Vaisala exhibition booth.<sup>3</sup>

Humicap was, indeed, a radical innovation that changed humidity measurements for good. In fact, the construction was so radical that customers had a hard time believing it would actually work in various environments. Nevertheless, Pekka Kostamo and other Vaisala managers persuaded customers around the world to test the new instrument and report the results. Yutaka Watari, a local marketing director of Vaisala humidity instrumentation in Japan recalls: "At first it was quite difficult to introduce the Vaisala Humicap because no one instantly believed in its characteristics or capabilities. Many earlier experiments had been made with other sensors and much energy had been expended, but no one had succeeded in measuring relative humidity well. So when the Vaisala Humicap was introduced in Japan, people were skeptical."<sup>4</sup> However, the skeptics soon became believers, as they saw how well the sensor worked in demanding conditions.

*An edited extract of the Vaisala history book, published in 2006.*

<sup>2</sup> Eero Salasmaa and Pekka Kostamo. 1975, pp. 10.

<sup>3</sup> Pekka J. Kostamo, *TECOMAP in Helsinki*. Vaisala News 59/1973, pp. 11-12.

<sup>4</sup> *Humicap in Japan*. Vaisala News 81/1979, pp. 10-11.

<sup>1</sup> Tuomas Suntola and Jorma Antson, *A Thin Film Humidity Sensor*. Vaisala News 59/1973, pp. 12.