2B Technologies — 2B Buzz

*Case Studies*

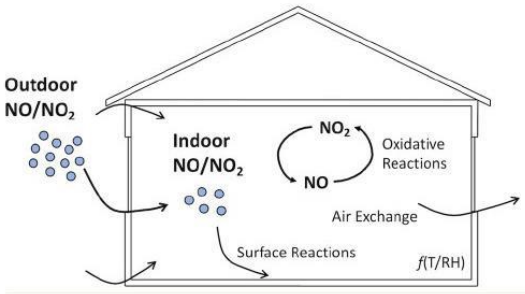
## Is the Indoor Environment a Refuge from Air Pollution?

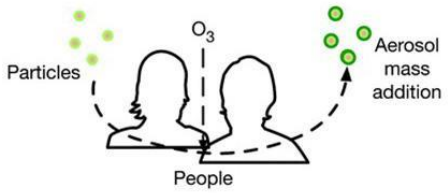
Pollution Infiltrates from Outside, but Also Has Unexpected Source Within

People spend most of their time indoors, so their exposure to pollution depends greatly on what takes place inside buildings and homes. 2B Tech instruments were used in two recent studies of the influences (from within and without) on the indoor air environment. The results of these and other studies have shown that closing the doors and windows is not a guarantee of reduced pollution. Indeed, it may even increase exposure in some situations.

Zhao et al. used a 2B Tech Model 405 nm $NO_2$/NO/NOx Monitor in their study of how ambient nitrogen oxides fare when crossing the boundary from outside to inside a building. Using an unoccupied apartment with no indoor sources (such as cooking and heating), the researchers conducted long-term tests (24-48 hours) of how the indoor $NO_x$ concentrations rose and fell in response to elevations of $NO_x$. Overall, the indoor environment removed about 30% of the $NO_2$ (through reactions with materials inside the building), with the results depending on relative humidity. In contrast, NO was virtually unaffected by the transition to the indoors, but the amount of ozone in the infiltrating air is a factor because of its reaction with NO.

Avery et al. looked at sources of indoor particle pollution (aerosols), which are known to come from outside air as well as from indoor activities such as cooking, cleaning, and smoking. However their findings, which made use of a 2B Tech Model 211 Scrubberless Ozone Monitor as well as other instrumentation, identified a source not previously quantified: the human occupants themselves. Particularly in rooms where a lot of people congregate, such as classrooms, offices, and airplanes, emissions from skin, breath, or personal care products can directly contribute. Indirectly, secondary aerosols can arise from the reactions of airborne oxidants with skin. Using a mass spectrometer, the researchers showed that large hydrocarbon ion fragments consistent with squalene ($C_{30}H_{50}$) were enhanced in the sampled aerosols when humans were present in a classroom. On average, the organic aerosol loading was increased by about 25%. The research showed that in the case of poorly ventilated and/or highly occupied spaces, the human presence can be a significant contributor to particles in the indoor environment.




In rwo recent papers, 2B Tech instruments were used to study indoor air quality issues. **Top**: Zhao et al. looked at how NOx is affected by the transition from the outside to the inside environment. **Bottom**: Avery et al. found that humans themselves can be an important source of primary and secondary aerosols in high-occupancy or low-ventilation indoor spaces such as classrooms and airplanes.

These and other studies illustrate that the issue of indoor air quality is complex. For example, a 2018 study by Reisen et al. in Australia that is particularly relevant to that country's current crisis showed that during biomass burning events,

avoiding the smoke by retreating inside can have mixed results. Researchers found that exposure to particulate pollution from Australian bushfires can indeed be minimized by remaining indoors and closing windows, but avoidance varies widely (12-76%) based on the age, construction, and ventilation status of the home. However, particle exposure indoors actually can be higher than outdoors if windows and doors remained closed after the smoke plumes outside have subsided, or if indoor sources such as smoking and cooking are high.

---

Measuring the Building Envelope Penetration Factor for Ambient Nitrogen Oxides, H. Zhao, E.T. Gall and B. Stephens, *Environmental Science & Technology*, **53**, 9695-9704, 2019.

Human Occupant Contribution to Secondary Aerosol Mass in the Indoor Environment, A.M. Avery, M.S. Waring and P.F. DeCarlo, *Environmental Science: Processes & Impacts*, **21**, 1301-1312, 2019.

**Model 405 nm NO2/NO/NOx Monitor** | **Model 211 Scrubberless Ozone Monitor**

---

*2B Tech Announcement*

## European Certification Achieved: The Model 405 nm $NO_2$/NO/$NO_x$ Monitor

We are pleased to announce that our combined $NO_2$/NO/$NO_x$ monitor has been certified to European Standards EN 14211 and EN 15267 (Air Quality - Automated Measuring Systems). The Model 405 nm earned this status through rigorous lab and field testing of the instrument over a period of several months and a detailed on-site audit of 2B Technologies' quality, manufacturing and calibration processes, all carried out by TÜV-Rheinland Energy GmbH.


The Model 405 nm was certified in 2017 as a Federal Equivalent Method for $NO_2$ through the U.S.-based Environmental Protection Agency. The addition of the European Standards opens the instrument up to broader markets. Thirty countries are bound to implement EN 15267-1, including Germany, the UK, France, Switzerland, Spain, Netherlands, Norway, Greece, and Italy.

The Model 405 nm provides a direct measurement of $NO_2$ (via absorbance at 405 nanometers) while also providing NO and $NO_x$ measurements. We look forward expanding its use in Europe!

**European EN Certificate** | **U.S. FEM Certificate**

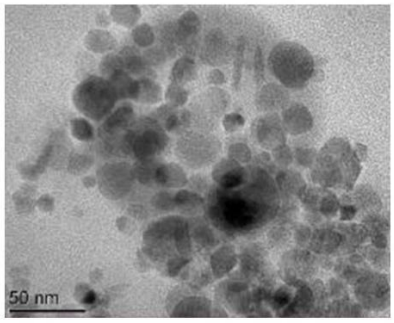
---

***(continued next page)***

*Air Pollution News*

## Escaping Detection: Ultrafine Particles

Nanoparticles May Be the Largest Air Health Quality Threat




> **A cloud of a billion 10nm particles has the same mass as just one PM10 particle, but a combined surface area a million times larger**

In a November issue of *BBC Future*, journalist Tim Smedley explains that when it comes to airborne particles and their importance to human health, it's time for us to... *think smaller*.

As in, nanoparticles.

Nanoparticles have diameters of 100 nanometers or below, which is at least 25 times smaller than the smallest subject of air quality regulations ($PM_{2.5}$, maximum diameter of 2.5 microns, or 2500 nanometers). Being smaller, the nanoparticles more readily find their way into organs and the bloodstream. The greater surface area of small particles versus larger particles increases their potential toxicity. Nanoparticles arise, for example, when the gases in vehicle exhaust cool. The nanoparticles then accumulate into larger particles as they move away from the tailpipe.

Early work in 2003 at Imperial College in London used a then-new technology for counting nanoparticles as small as 2 nm. The work revealed that while $PM_{2.5}$ did not change much when pedestrians went a few steps closer to the curb of a busy road, the nanoparticle exposure took a large jump. A few years later at Cambridge University, studies showed that 90% of the particles by busy roads are nanoparticles, and that children in strollers receive much higher exposures than adults because they are closer to tailpipe-level. In 2017, research at the University of Edinburgh was the first to show just how small the nanoparticles have to be in order to pass into the bloodstream (result: 30 nm and below). It was also shown that the nanoparticles can even adhere to the plaque that builds up in arteries, delivering toxins directly to the site of cardiovascular stress.

As research progresses and technology advances, the world of air quality monitoring and regulation is bound to move closer to the reality of nanoparticles.

---

The Toxic Killers in Our Air Too Small to See, T. Smedley, *BBC Future*, 15 November 2019.

**Link to Article**

---

*2B Tech Distributors*

## Several European Distributors Meet in Germany

Over 25 distributors around the world, shown on the map on our website, are crucial international partners in the 2B Technologies endeavor. They carry out sales to customers outside the U.S./Mexico/Canada and provide direct information and support to users of 2B Tech's full range of instruments.

Several of our European distributors gathered in October 2019 in Essen, Germany, at a meeting hosted by Klaus and Daniela Beckert of Envilyse, our German distributor. 2B Tech's John Birks (founder and President), Craig Williford (VP for Operations), and Jessa Ellenburg

(Director of Educational Outreach) presented an overview of 2B Tech's products and markets, emerging market opportunities, technical information, service and parts. Attendees participated in lively discussions on technical matters, maintenance of monitors, common service issues, and sales and marketing ideas.

Distributors represented at the meeting were: Envilyse (Germany), ACOEM (Norway/Sweden/Finland), Air Monitors (UK), AirQIS (Netherlands), DLK Technologies (Switzerland), Equipements Scientifiques (France), Tecnasa (Spain/Portugal) and KemLab (Hungary).

2B Tech greatly appreciates the information and suggestions of its distributors, some of which have already been implemented. (Keep the ideas coming!)

Meeting organizers Daniela Beckert (second from left) and Klaus Beckert (right) continue discussions with 2B Tech's Jessa Ellenburg, John Birks and Craig Williford after the European distributor meeting on October 29.

---

## *Meet Our Product Manager*
## Brian Carpenter

In 2012, Brian Carpenter was a senior at the University of Colorado Boulder, and he needed an internship credit to graduate with his degree in Environmental Science. As luck (and fate!) would have it, he took an intern position with 2B Technologies that not only led to his degree, but launched his career with the company.

Starting first with the intern work developing atmospheric science curricula for 2B's education-focused GO3 Project, Brian moved into manufacturing the ozone monitors' optical benches for the first 2 years after graduation. It was perfect preparation for then taking on his current job as 2B Tech's Product Manager, specializing in the new instruments that 2B adds to its ever-advancing lineup. He started with the Model UV-106-W Aqueous Ozone Monitor and now has added the Model 405 nm $NO_2/NO/NO_x$ Monitor, the Model 714 $NO_2/NO/O_3$ Calibration Source, and the Black Carbon Photometer to his realm. When one of the "newbies" is being developed, Brian acts as an interface between R&D and Production, helping to analyze and optimize instrument design, construction, and performance as it moves from the lab bench to the manufacturing process. He's skilled at designing the kinds of robust tests of the instrument that often lead to ideas for improvements before the product is launched. Also, when the instruments come back for calibration or repairs, Brian brings the instruments back into spec. He's traveled in the U.S. and internationally to help customers and distributors with their instruments, something he views as one of the definite "perks" of his job.

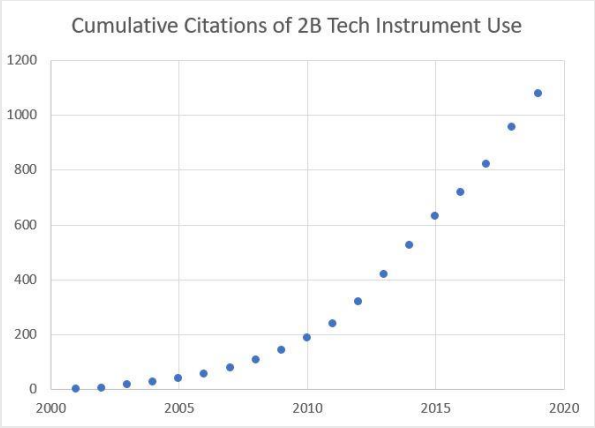
Brian has lived in Colorado for most of his life and now makes his home in Longmont with his wife Kimberley and their 2 dogs, 2 cats, and 1 corn snake. He's been known to infuse a little of his high-tech mojo into home projects, and in his spare time you'll find him renovating the house, designing the garden, hunting, fishing, bicycling, and motorcycling.

---

*2B Tech News*

## Number of Publications Citing Use of 2B Tech Instruments Tops the 1,000 Milestone

2019 Papers Are Sorted by the Specific Instrument Used




2B Tech keeps track of the publications that cite the use of our instruments, and the list shows a wide range of applications that includes atmospheric science, medical research, food science, water treatment, and many others. We take pride in the fact that our instruments have enabled advances in so many areas (and that they've been used in several thesis studies that helped launch the careers of many young scientists).

Our current tally, through 2019, is 1,079 publications. You can see the full listing on our website. New for this latest update is that for the year-2019 publications, we have sorted the list to show which instrument was used in the study. So if you are thinking of purchasing a 2B Tech instrument, you can browse the recent papers that made use of a particular model.

**2B Tech Citations List**

---

*2B Tech News*

## 2B Tech Awarded Phase II NSF Grant

"AQSync" Multi-Pollutant Air Pollution Monitor to Be Developed

2B Tech recently learned that it has been awarded Phase II of its NSF grant, "AQSync for Drive-By Calibrations of Mobile Air Quality Sensing Platforms."

In this work, we will use the Black Carbon Photometer developed in Phase I, along with other instruments, to develop a compact multipurpose, multi-pollutant "AQSync" air pollution monitor. Ozone, $NO_2$, NO, and black carbon will be measured using the approaches of our Model 106-L Ozone Monitor, Model 405 nm $NO_2$/NO/NOx Monitor, and the Black Carbon Photometer. $PM_1$ and $PM_{2.5}$ will be measured using an optical particle counter. $CO_2$ will be measured by NDIR, and CO will be measured using an electrochemical sensor. The AQSync also will include a meteorological package for measuring wind speed and direction, temperature, pressure, and humidity.

A primary motivation for developing AQSync is its use for drive-by validation and calibration of mobile air sensing platforms such as those currently being deployed by Aclima on Google Street View cars. The stationary AQSync could be located on street corners or other places that enable frequent checks of the mobile sensing packages, which have multiple instruments and sensors that need frequent calibration to maintain data quality. The AQSync package could also help expand the capacity for air pollution monitoring in developing countries where costs of traditional monitoring stations have precluded air quality monitoring, and it could be used for calibration checks of wearable air pollution sensors currently under development.

2B Tech began work on the 2-year grant in November 2019.

2B Tech Website

Get Quote

Our Team

Newsletter Archive

Helpful Downloads

**2B Technologies**

2100 Central Avenue, Suite 105| Boulder, Colorado USA
303-273-0559 | sales@twobtech.com