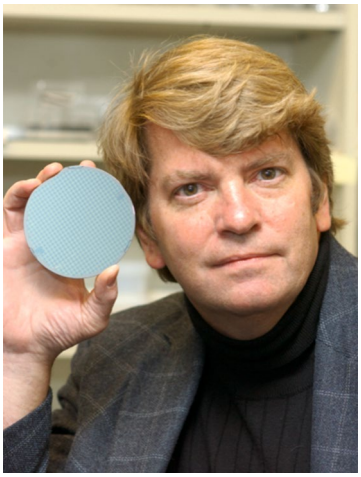
# Mark A. Reed (1955–2021)

Mark Reed led many of the early discoveries in nanotechnology in 1980–1990s with projects spanning electronic transport in mesoscopic systems and molecules to nanofluidics and bioelectronics. He was an intellectual pioneer, daring to explore research topics that others might deem impossible or too difficult. His modus operandi could be summarized as 'never fear'.

He was the signature hire for the fledgling nanoelectronics programme at Texas Instruments (TI) in 1983, just after he completed his PhD at Syracuse University. His insights in exploiting quantum mechanics for new devices led to the demonstration of zero-dimensional tunnelling in a heterostructure device he termed the 'quantum dot' (M. A. Reed et al., *Phys. Rev. Lett.* **60**, 535–537; 1988). This discovery led to decades of research on semiconducting quantum dots, quantum computing and numerous applications including semiconducting lasers and telecommunications. Mark pioneered the investigation of unipolar and bipolar resonant tunnelling transistors with an aim to add new functionality and enable new computing architectures. Early works of his on resonant tunnelling transistors were the precursors to current efforts in steep-subthreshold-swing tunnel field-effect transistors. His tireless enthusiasm and creativity energized early efforts at TI and his ideas continue to reverberate through the research community.

Reed was recruited into the Yale faculty in 1990 and developed a visionary research programme on molecular electronics. His insights into nanofabrication and nanotechnology and its capabilities for allowing exploration of seemingly impossible measurements inspired all who knew him. His students vividly recall group meetings full of his boundless enthusiasm with comments such as 'rules are meant to be broken!'. At the time, it was thought that electronic transport through a single molecule or a single atom was impossible in an electronic device because of physical limitations in nanofabrication. His immeasurable optimism and scientific intuition would soon lead to a work around. Sure enough, in collaboration with James Tour's group at Rice University, his group showed how transport properties of molecules could be measured. In 1997 his group demonstrated conductance through a single molecule (M. A. Reed et al., *Science* **278**, 252–254; 1997) and later went on to demonstrate a single molecule transistor.



Credit: Yale University

These results sparked broad interest in the field, which continues today.

"What was remarkable about Mark was that he was sincerely genuinely kind and caring. He would go out of his way to help students and staff in the way they needed to be helped at any time. The result was that we always felt we truly owned what we were doing" says former post-doc James Klemic. More recently Reed's research programme applied his legendary understanding of nanotechnology to bioelectronic systems and nanofluidics. His group demonstrated label-free immunodetection using semiconducting nanowires (E. Stern et al., *Nature* **445**, 519–522; 2007). They then showed how microfluidic purification prior to sensing can allow for biomarker detection from whole blood, a significant challenge for nanowire systems.

Many of his 23 PhD students and 14 post-docs went on to join or found start-ups, and he continued to support them by investing in the companies and also scientifically by discussing science with his former students, even many years after their thesis. "Mark was a true teacher; he could leave a long lasting mark on you. Still today, 25 years after I was in Mark's lab, I still feel his words supporting me" says former student Mandar Deshpande. In tribute to each of his PhD students, he made a photolithographically etched silicon wafer in honour of each thesis. The board with these silicon wafers was placed in a prominent position in Mark's office and were an oft subject of conversation during a visit. As a memorial to him, the board will remain at Yale near his former laboratory.

Reed also cared deeply about his department at Yale and about mentoring undergraduate students. He was proud to be the director of undergraduate studies at the electrical engineering department for numerous years. "During a research meeting, some undergraduate students came in with a question. Mark stopped the meeting and for about 10 minutes to help them, clearly bending over backwards and excited to answer their questions. Being a mentor to everyone was just second nature to him" reminisces Peter Burke, a collaborator from UC Irvine.

Reed was born in Suffern, New York and grew up in Syracuse, NY where he attended the Christian Brothers Academy. He went on to receive his BA, MS and PhD in physics from Syracuse University. "Outside of school he enjoyed hunting, fishing in upstate New York and learned woodworking from his father, Arthur. The black walnut furniture in his home was designed by Mark and his father; the wood originated from trees he felled with his father and brother. As an adult Mark became an accomplished divemaster, and as such we enjoyed unique dives such as shipwrecks, wall dives, deep dives and night dives. He had a knack for finding the most unique places to vacation and made it a point to find traditional private accommodations to be able to fully experience the different cultures around the world" recalls his wife, Elizabeth J. Reed.

"Mark was a tireless innovator, bringing to life countless ideas for innovative devices to improve health and human lives. We were made better by his presence, and we will miss him dearly" said Jeffrey Brock, dean of the School of Engineering & Applied Science (SEAS) at Yale after learning of his passing last spring.

Mark Reed lives on in all of us who had the honour to be mentored by him or worked with him. ❐

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