Many electrophilic trifluoromethylating reagents have emerged in the past three decades. Among them, Umemoto’s reagent and Togni’s reagent are two of the most studied electrophilic trifluoromethylating reagents due to their high reactivity and broad substrate scope. Nevertheless, new, highly reactive and easily prepared electrophilic trifluoromethylating reagents are still urgently needed.

Recently, the group of Professor Qilong Shen at the Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences (P. R. of China) discovered that monofluoromethyl- ordifluoromethyl-substituted sulfonium ylides, which could be synthesized from 4-nitrophenylthiol in two steps, were highly active and reacted with a broad range of nucleophiles under mild conditions. However, the reactivity of the corresponding trifluoromethyl-substituted sulfonium ylide was only moderate. “It is generally accepted that the bond strength of carbon–selenium bonds is weaker than that of carbon–sulfur bonds. We thus reasoned that a trifluoromethyl-substituted selenium ylide might act as a more powerful electrophilic trifluoromethylating reagent,” explained Professor Shen. He continued: “We then successfully developed a procedure that led to the synthesis of the trifluoromethyl-substituted selenium ylide 1 from 4-nitrophenyl diazonium salt in two steps (Scheme 1).”

As expected, this compound was indeed a powerful electrophilic trifluoromethylating reagent, which could react with a variety of nucleophiles including β-keto esters, silyl enol ethers and aryl/heteroaryl boronic acids (Scheme 2). In addition, irradiation of 1 with visible light easily generated the trifluoromethyl radical, which reacted readily with electron-rich heteroarenes and sulfonates in high yields. Finally, it was found that diarylselenide was a major side product that could be reused to synthesize the reagent. Professor Shen remarked: “Overall, its ease of preparation, convenience in purification, and high thermal stability in the solid state yet high reactivity in solution made the trifluoromethyl-substituted selenium ylide 1 a magic wand for incorporation of the trifluoromethyl group into the target molecules.”

Professor Shen went on to summarize five key points of the group’s findings: “First, the time for preparing the reagent is short, about one hour. Second, the purification by recrystallization is convenient and there is no need for column chromatography. Third, 1 has very good thermal stability in the solid state; it is not moisture-, air- or light-sensitive either. Fourth, it requires only mild reaction conditions. Finally, late-stage modification is possible.”

Professor Shen concluded by mentioning some future prospects: “Very recently, we discovered that in the presence of a photoredox catalyst, trifluoromethylative difunctionalization of styrene derivatives using the reagent occurred with a broad substrate scope and in high yields. Our lab is currently investigating this process.”

REFERENCES
Scheme 2 Trifluoromethylation reactions performed with the new reagent

About the authors

**Qilong Shen** was born in 1974, in Zhejiang (P. R. of China). He studied for his Bachelor’s degree from 1992–1996 in Nanjing University (P. R. of China) and his MS from 1996–1999 at the Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences (P. R. of China) with Prof. Long Lu. He remained there for one more year as a research assistant, still with Prof. Long Lu, before moving to the USA in 2000 to complete another MS degree at the University of Massachusetts at Dartmouth (USA) under Prof. Gerald B. Hammond. From 2002–2007, he undertook his PhD studies at the Department of Chemistry, Yale University (USA) with Prof. John F. Hartwig before moving to the University of Illinois, Urbana-Champaign (USA) as a postdoctoral researcher with Prof. Jeffrey S. Moore. He remained there until 2010, when he moved to his present position as a professor at the Shanghai Institute of Organic Chemistry, Chinese Academy of Science.

**Hangming Ge** was born in 1993 in Liaoning (P. R. of China). He studied for his Bachelor’s degree in 2011–2015 at East China Normal University with Prof. Qiancai Liu, where his research was centered on the synthesis of fluoranthene-fused thiophene and pyrrole, and palladium-catalyzed Suzuki coupling towards 1,8-naphthyridines. Since 2015 he has been a PhD candidate at the Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences under Prof. Qilong Shen. His research focuses on the synthesis and applications of electrophilic reagents for trifluoromethylation based on selenium ylides.