

Making polymers from a greenhouse gas

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A future where power plants feed their carbon dioxide directly into an adjacent production facility instead of spewing it up a chimney and into the atmosphere is definitely possible, because CO2 isn't just an undesirable greenhouse gas; it is also a good source of carbon for processes like polymer production. In the journal *Angewandte Chemie*, American scientists have now introduced a two-step, one-pot conversion of CO2 and epoxides to polycarbonate block copolymers that contain both water-soluble and hydrophobic regions and can aggregate into nanoparticles or micelles.

CO2 and epoxides (highly reactive compounds with a three-membered ring made of two carbon atoms and one oxygen atom) can be polymerized to form polycarbonates in reactions that use special catalysts. These processes are a more environmentally friendly



alternative to conventional production processes and have already been introduced by several companies. However, because current CO2-based polycarbonates are hydrophobic and have no <u>functional groups</u>, their applications are limited. In particular, biomedical applications, an area where the use of biocompatible polycarbonates is well established, have been left out.

A team led by Donald J. Darensbourg along with graduate student Yanyan Wang at Texas A&M University (USA) has provided a solution. For the first time, the researchers have been able to produce amphiphilic polycarbonate <u>block copolymers</u> in which both the hydrophilic and hydrophobic regions are based on CO2. They were also able to incorporate a variety of functional and charged groups into the polymers. Because it is very difficult to find building blocks to make hydrophilic polycarbonates, the researchers used a trick: they polymerized first and attached the water-soluble groups afterwards.

The entire process is even a "one-pot reaction": The researchers first produce the hydrophobic regions by polymerizing CO2 and propylene oxide (as the epoxide component). In the same vessel, they then change to a different building block, allyl glycidyl ether (AGE), an epoxide with a double bond in its side chain, and continue the polymerization. The AGE-containing polymer grows on both ends of the existing polycarbonate, leading to a triblock copolymer. The length of the blocks can be controlled precisely. Subsequently a "thiol–ene click reaction" can be used to simply "click" a water-soluble group into place at the double bond. This makes it possible to attach acidic and/or basic groups that carry a positive or negative charge in certain pH ranges. Some of the amphiphilic polycarbonates made by this method are able to aggregate into particles or micelles in a self-organization process. This, and the ability to attach bioactive substances, for example, could provide many more possibilities for biomedical applications.



More information: "Construction of Versatile and Functional Nanostructures Derived from CO2-based Polycarbonates." *Angew. Chem. Int. Ed.*. doi: 10.1002/anie.201505076

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