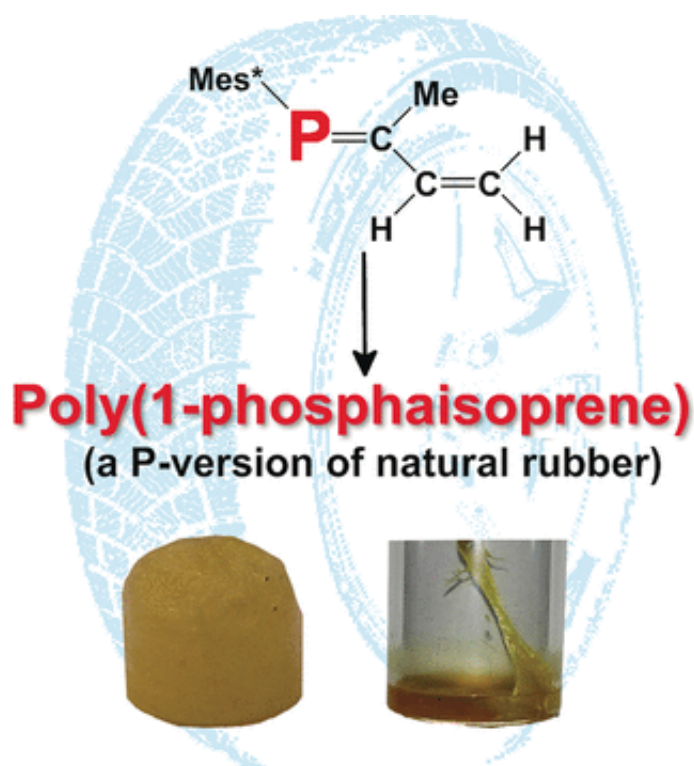


# A chemically functional phosphorus version of natural rubber

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Goodyear's 1839 discovery of the vulcanization of natural rubber obtained from rubber trees marks the beginning of the modern rubber industry. A variety of synthetic rubber products were subsequently developed. In the journal *Angewandte Chemie*, scientists have now introduced a new, interesting variant: a phosphorus-containing rubber

with a structure that corresponds to that of natural rubber.

The similar properties of double bonds between carbon atoms ( $C=C$ ) and phosphorus–carbon double bonds ( $P=C$ ) led to the idea to try general polymerization techniques on the latter. After a number of successful attempts, researchers working with Derek P. Gates at the University of British Columbia (Vancouver, Canada) wanted to apply this concept to molecules that contain both  $P=C$  and  $C=C$  double bonds: phosphorus analogs of the building block of [rubber](#), isoprene (2-methylbuta-1,3-diene) and its close relative, 1,3-butadiene.

Starting with phosphorus-containing precursors, the team was able to synthesize the first examples of poly(1-phospha-isoprene) and poly(1-phospha-1,3-butadiene). Precise characterization with a variety of spectrometric techniques gave some insight into the molecular structures of the resulting polymers. Like in the polymerization of isoprene and related dienes (compounds with two carbon-carbon double bonds), one of the double bonds in each building block is retained. The polymerization mainly occurs through the  $C=C$  double bonds and only a tiny proportion happens at the  $P=C$  double bonds. This means that only a few [phosphorus atoms](#) are incorporated into the polymer backbone. The majority of the phosphorus atoms form side chains in which the  $P=C$  [double bonds](#) are maintained, leaving them available for further reactions or alterations to the polymers.

"Our functional phosphorus-containing materials are rare examples of polymers containing phosphalkene moieties and offer many prospects for further derivatization and crosslinking," according to Gates. For example, the researchers were able to bind [gold ions](#) to the polymers.

"As a macromolecular ligand for gold ions, the new polymers may be of future interest in catalysis and nanochemistry. Furthermore, the successful polymerization of  $P=C/C=C$  hybrid monomers opens the door to incorporate P-functionalities into commercial rubbers such as butyl

rubber or styrene-butadiene rubber that traditionally use isoprene or butadiene comonomers. Such new copolymers promise unique architectures, properties, and functionality when compared to their carbon-only analogues."

**More information:** Klaus Dück et al. Polymerization of 1-Phosphaisoprene: Synthesis and Characterization of a Chemically Functional Phosphorus Version of Natural Rubber, *Angewandte Chemie International Edition* (2017). [DOI: 10.1002/anie.201703590](https://doi.org/10.1002/anie.201703590)

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