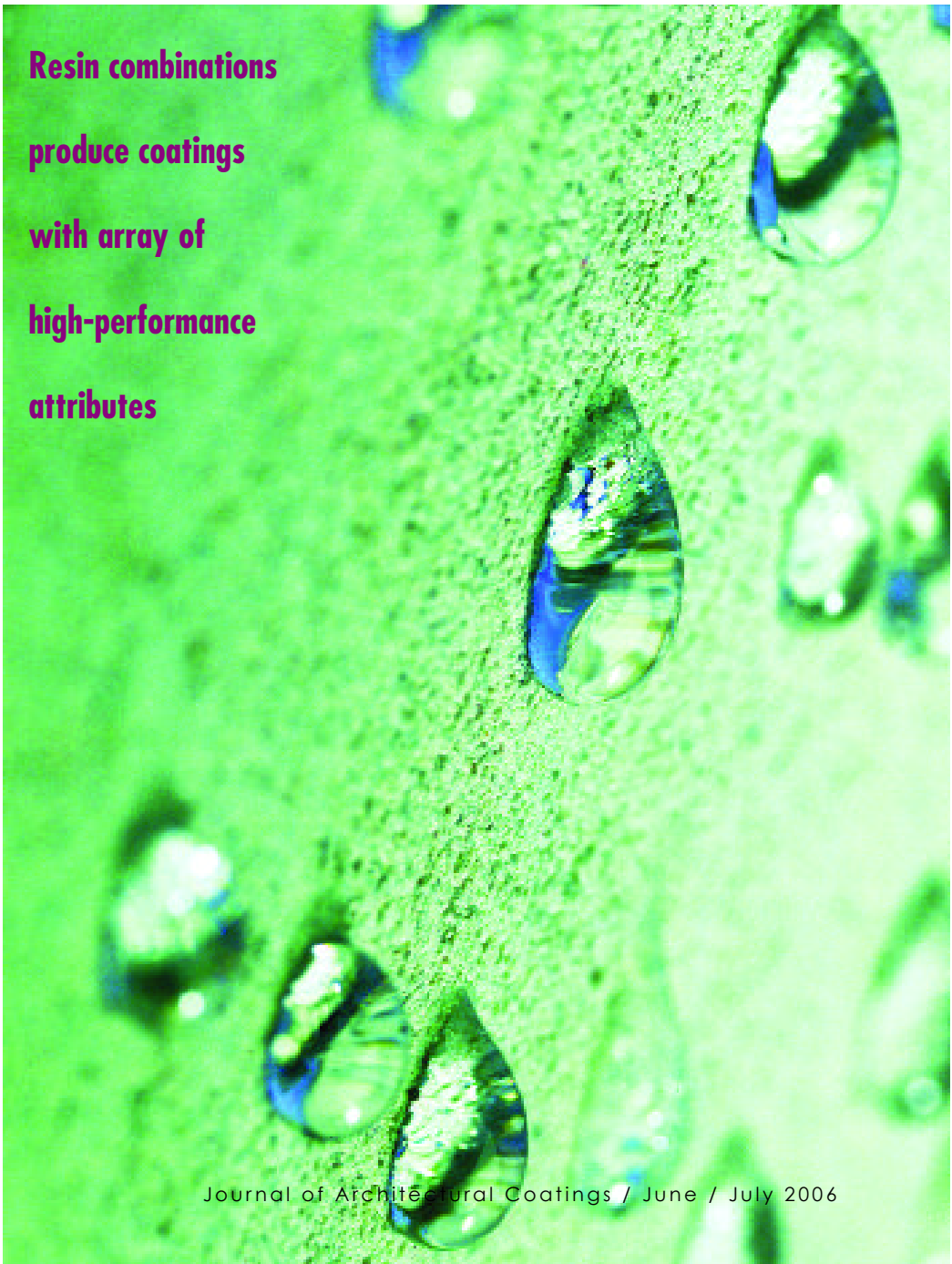
# Polysiloxanes:

## A new chapter in the saga of silicon science




*By Nicholas Wood, Degussa Tego*

### Introduction

Silicon is one of the most abundant elements in nature. The earth's crust itself is comprised of approximately 28% silicon, mostly in the form of silicate minerals—such as quartz—that are found in many types of rock. Silicon is in the same chemical family as carbon, and parallels exist between the chemistry of silicon and carbon-based organic chemistry.

Whereas carbon can form polymer chains consisting of a backbone of car-

*Photos on p 27–28 show polysiloxane coatings in use*
*Photos courtesy of Degussa Tego*

bon atoms, silicon can form polysiloxanes. These polymer-like structures, also known simply as siloxanes or silicones, are based on a backbone of alternating silicon and oxygen atoms.

Film-forming organic polymers are employed as binders in paints and coatings. Similarly, binders can be made from polysiloxanes, producing cured films with distinctly different properties compared to those based on conventional organic resins. These properties, for example, may include enhanced heat and weathering resistance. It is these different properties that make polysiloxane resins interesting to a coatings formulator.

### The history of silicon and silicones in coatings

Silicon-based binders have found use in coatings since early in the 19th century, when paints based on metal silicates were used as exterior coatings for masonry. High-performance exterior masonry paints based on silicone resin emulsion binders provide highly hydrophobic, water-repellent properties while remaining permeable to water vapor, an important combination of attributes for the performance of exterior coatings. Many coatings additives, such as defoamers and substrate wetting agents, contain silicones and organically modified silicones.

Due to the strength of the chemical bond between silicon and oxygen, coatings films based on polysiloxanes tend to be highly stable and inert. As a result, these coatings are resistant to attack from heat, solar radiation, oxidation, and other types of chemical reaction that can adversely affect coating integrity. As a result, silicone resins are frequently used in the formulation of heat-resistant coatings, sometimes in combination with other, organic resin types. For example, silicone-modified polyesters are used as binders for non-stick cookware and bakeware.

To obtain a high-temperature-resistant coating, a silicone resin will normally be employed as the sole binder. When this coating is subjected to high temperature, a crosslinked network based on the silicon-oxygen backbone is formed. Typical applications for this kind of coating would be ovens, barbeques, chimneys, car mufflers and other automotive components.

### Chemistry combinations

The properties of films made from polysiloxane resins can be very different from films cast using organic polymers. Of particular interest is these coatings' resistance