



stressed and brittle than non-treated hair—by increasing the breaking load considerably; to a level higher than that of uncolored hair.

### Materials and Methods: Anti-frizz Effect

A high degree of fiber alignment makes hair smooth, shiny and practically free from frizz. However, high-humidity conditions can quickly destroy temporary fiber alignment attained through heat styling, and the rate and extent of style loss is typically proportionate to climatic conditions. Indeed, hot, humid days lead to especially rapid style deterioration.<sup>7</sup>

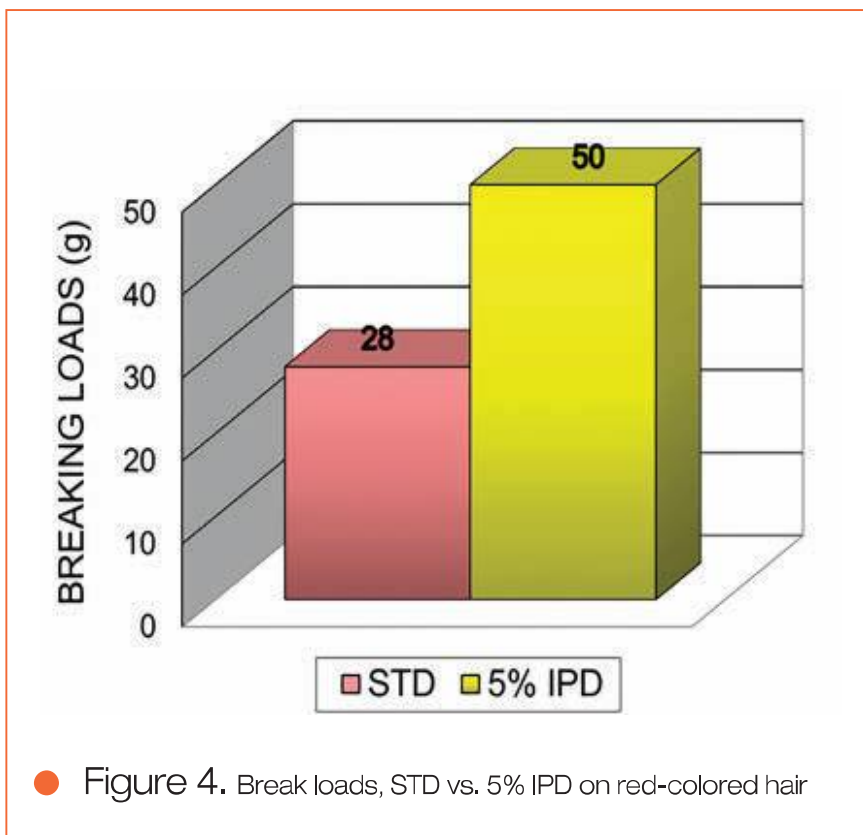
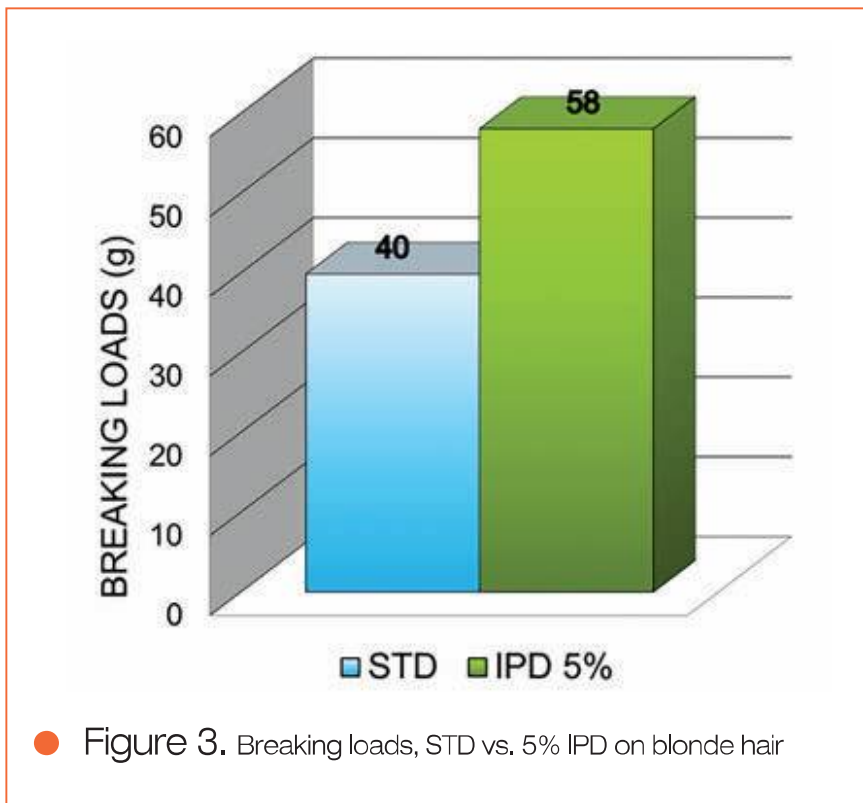
In order to quantitatively evaluate the anti-frizz effect of IPD, a test was carried out comparing wavy hair strands cleansed with a

### ● Formula 2. Anti-frizz Test Conditioner

Water ( <i>aqua</i> )	qs to 100% w/w
Panthenol	0.05
Disodium EDTA	0.25
Hydroxyethylcellulose	0.75
Distearyldimonium Chloride	2.00
Cetearyl Alcohol	3.00
BHA	0.10
Ceteareth-20	1.00
Glyceryl Stearate	2.00
Isoamyl Laurate	2.00
Water ( <i>aqua</i> ) (and) Cetrimonium Chloride	1.50
Phenoxyethanol	0.80
Sodium Benzoate	0.30
Lactic Acid (and) Water ( <i>aqua</i> )	0.10

*A high degree of fiber alignment makes hair smooth, shiny and practically free from frizz.*





shampoo and conditioner containing IPD or not (benchmark), and stored in hot and high humidity conditions for several hours.

**Hair strands:** For the anti-frizz test, wavy, dark brown European hair, 16-18 cm long, was divided into six bundles weighing approx. 2.5 g each. Three bundles (STD) were cleansed with the basic shampoo (see **Formula 1**) and a basic conditioner (see **Formula 2**). The other three strands were treated with shampoo and conditioner containing IPD—at 2.5% in the shampoo and 5% in the conditioner.

**Figure 5** shows a representative wavy hair bundle.

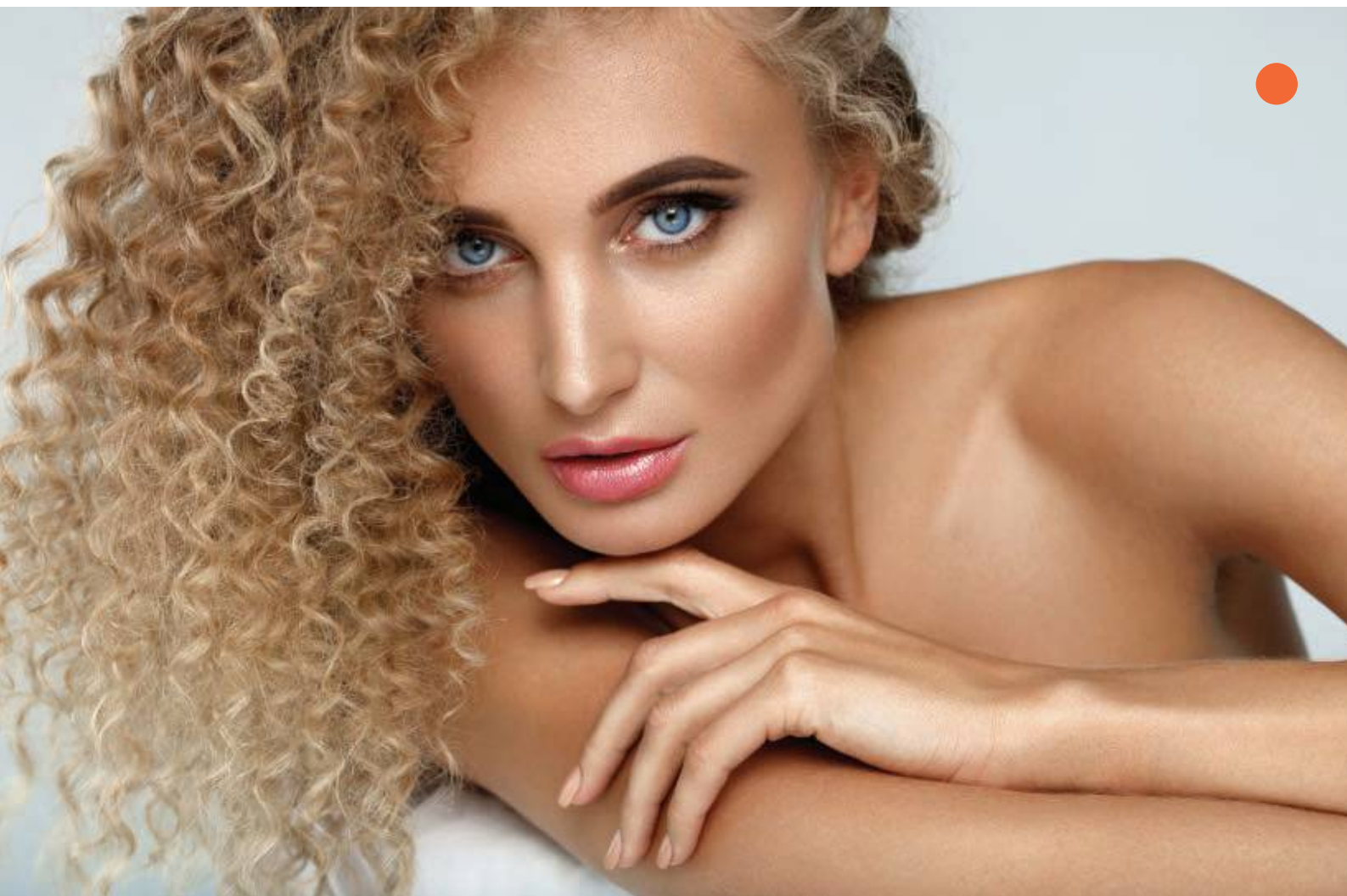
**Procedure:** The hair strands were washed with shampoo for 1 min and treated with the conditioner for another minute. They were then blown dried and straightened using a hair straightener. The samples were stored in a chamber<sup>c</sup> at 35°C and 75% RH, and hung up on a grill, at the back of which a sheet of graph paper was arranged vertically (parallel to the strands). Strand lengths and widths were then measured using the millimeter paper sheet after increasing time intervals; i.e., 1, 2, 3 and 24 hr of storage.

## Results: Anti-frizz

**Figures 6–8** show photos of the straightened wavy hair at T=0 and after 1 hr and 3 hr of storage.

<sup>c</sup> Stove Binder series BD-115





*Hair bundles treated with IPD kept a straight shape, even in the face of natural waves.*

Bundles treated with IPD were less frizzy overall at the start of the experiment. They also keep a straight shape, even in the face of challenging natural hair waves (see IPD3 strand, which has a large wave in the center).

To quantify the anti-frizz effect of IPD, measurements for the shortening and widening of tresses were considered. While the shortening of hair bundle dimensions were similar among samples and insignificant, the widths of STD bundles were much larger than treated with IPD. These differences were significant until 3 hr after treatment. After 24 hr, all strands were similarly frizzy and the difference was no longer significant. Since no styling fixatives were used on the hair strands, the effects achieved with this simple test were considered good. **Table 10** shows the width (cm) of the bundles at different times.

## Discussion

The amphiphilic properties of IPD could explain the surprising results obtained in hair treatments. In addition, the molecule is quite small, therefore canon polar sites easily diffuse in depth into the hair structure.



● Figure 5. Wavy hair bundle