

Short Communication

Airborne occupational allergic contact dermatitis due to trimethylolpropane triacrylate (TMPTA) used in the manufacture of printed circuit boards

LASSE KANERVA, KYLLIKKI TARVAINEN, RIITTA JOLANKI, MAJ-LEN HENRIKS-ECKERMAN AND TUULA ESTLANDER
 Section of Dermatology, Finnish Institute of Occupational Health, Topeliuksenkatu 41 aA, FIN-00250 Helsinki, Finland

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Case Report

A 51-year-old nonatopic woman laminated photosensitive resists onto glass-fiber-reinforced copper-coated epoxy resin plates in the manufacture of printed circuit boards (PCBs). Part of the lamination was automatic, but she had to monitor the machine in a small room. The resist moved through a 120°C drying area, emitting a vapor. The patient wore cotton gloves. She had previously worked for 25 years in a shop selling clothes without skin symptoms. Having worked for 1 month in her new job, her eyes started to lacrimate, and she had conjunctivitis, itching and redness, especially of the lower lids. She was symptomless during weekends and vacations. She was initially examined elsewhere, and when first seen by us, she had been off her job for 2 months and was symptomless. An ophthalmologist had considered her eye symptoms as allergic.

4 patch test sessions were performed and scored according to the recommendations of the ICDRG. A modified European standard series, a series of plastics and glues (1), textile dyes, epoxy resins, thioureas, and

Table 1. Gas chromatographic/mass spectrometric analysis of acrylics in the resist

(Meth)acrylate compound	(%)
2-hydroxyethyl acrylate (2-HEA)	0.3
trimethylolpropane triacrylate (TMPTA)	0.08
hexyl methacrylate (HMA)	0.01
n-butyl acrylate (BA)	0.001
N,N-dimethylaminoethyl methacrylate	0.001

(meth)acrylates (2; Chemotechnique Diagnostics AB, Malmö, Sweden) revealed positive patch test reactions to balsam of Peru (+; 25% pet.), Kathon® CG (+; 100 ppm a.i. aq.), resorcinol monobenzoate (1%, ++), and trimethylolpropane triacrylate (TMPTA, 0.1% pet., Fig. 1) (+; tested 3×). Pieces of the resist tested *as is* in a drop of alcohol and acetone gave a + reaction, and in water, a ?+ reaction. Prick tests with environmental allergens and human serum albumin conjugated methyl methacrylate, 2-hydroxyethyl methacrylate and polyethyleneglycol dimethacrylate, prepared as previously described (3), were negative.

The manufacturer of the resist informed us that the resist contained a mixture of acrylic prepolymers and multifunctional acrylic polymers. We then analyzed the content of the resist by gas chromatography/mass spectrometry, as previously described (2); it contained minute amounts of acrylics including 0.08% TMPTA (Table 1).

The patient tried several times to return to work, but each time had to stop working after 2 to 10 days because of relapsing eye and eyelid symptoms. Eventually, she could not even work in the same industrial hall and had to change jobs.

Discussion

In the manufacture and assembly of PCBs, allergic contact dermatitis can be induced by many different agents (4, 5). Nethercott et al. (4) have reviewed the complex PCB manufacturing process, which involves 11 steps. It

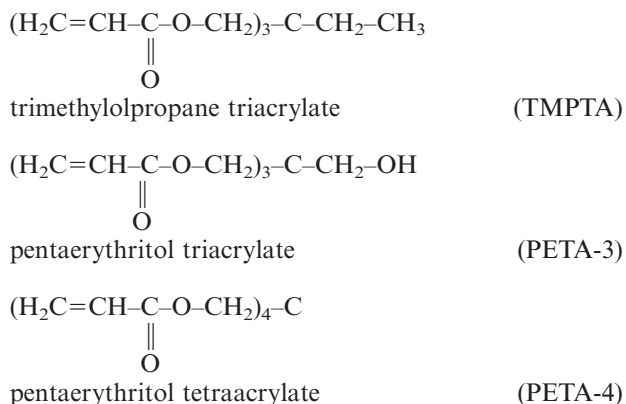


Fig. 1. Chemical structures of trimethylolpropane triacrylate (TMPTA), pentaerythritol triacrylate (PETA-3) and pentaerythritol tetra-acrylate (PETA-4).

is in the 4th of these steps, the application of a solder-resistant coating, that acrylics are used. The only relevant patch test reaction in our patient was that to TMPTA. The most common multifunctional acrylic compounds in UV-cured acrylate resins are those based on TMPTA, pentaerythritol triacrylate (PETA-3), pentaerythritol tetraacrylate (PETA-4) (Fig. 1) and 1,6-hexanediol diacrylate (HDDA) (6–8). Commercially-used PETA is a mixture of PETA-3 and PETA-4. PETA has a strong tendency to form cross-links, and is especially suitable for UV-cured printing inks. TMPTA has most of the PETA characteristics but has a lower viscosity and greater flexibility. These characteristics make TMPTA very useful in acrylic inks (8).

Based on guinea pig maximization tests, Björkner (6, 8) classified TMPTA as a strong sensitizer (class IV), and it has caused allergic contact dermatitis among printers and in the manufacture of UV-cured inks (7–13). It may cross-react with PETA-3 (6), but in the case of our patient, did not. In our patient material, allergic patch test reactions to TMPTA have not been seen in any other patients (14). Exposure to the volatile fumes of acrylic compounds may cause airborne contact dermatitis, as in our patient, in addition to conventional contact dermatitis (9). The patient also had allergic patch test reactions to resorcinol monobenzoate (RMB, 15) and balsam of Peru, which may cross-react (16). Balsam of Peru is a better known allergen than RMB, which is a UV-absorber used in the manufacture of cellulose ester plastics (16). The manufacturer informed us that the resist did not contain RMB, and the relevance of the allergic patch test reaction remained unknown, as did the allergic patch test reaction to Kathon® CG.

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