

Allergic Contact Dermatitis from Epoxy Resin in Solder Mask Coating in an Individual Working with Printed Circuit Boards

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Précis

Although allergic contact dermatitis from epoxy resin is well documented in the electronics industry, few reports have attributed its occurrence to the presence of solder mask coating on printed circuit boards.

Discussion

A 51-year-old Taiwanese male presented to our clinic with a 7-year history of dermatitis affecting his face, neck, arms, and hands. He reported working in a factory for the past 9 years applying green paint (solder mask or solder resist) onto printed circuit boards (PCBs). On physical examination, the patient had erythema, scaling, and fissuring on both of his hands, as well as erythematous patches on the ventral aspects of his forearms. Both his nose and his ears were erythematous, and the ears were mildly edematous. The patient was subsequently patch-tested with the North American Contact Dermatitis Group standard, cosmetic, and dental trays; he reacted to epoxy resin (+++) and bisphenol A glycidyl methacrylate (Bis-GMA) (+++). The Material Safety Data Sheet obtained from the solder mask manufacturer confirmed the presence of epoxy resin and epoxy acrylates.

Epoxy resins and related epoxy compounds (eg, epoxy [meth]acrylates and triglycidyl isocyanurate) are used in a variety of products involved in PCB construction and potentially cause both irritation and sensitization.¹ The board substrate is usually composed of woven fiberglass with an epoxy resin binder, which together serve as insulation from conducting copper pathways. Later in production, the board is coated with solder mask, a

PEARLS provide insight into understanding disease pathogenesis or improving treatment. ZEBRAS inform about previously unrecognized conditions or atypical variants of known disorders.

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lacquerlike epoxy liquid that provides a protective solder mask coating to the copper areas where soldering will not be done. Text and line art may then be added by silk screen printing, a technique that uses a woven mesh stencil to transfer ink (which may also contain epoxy products) onto the board (Fig 1).

The application of solder mask is a multistep process that varies according to the type of product used. The factory where our patient worked used a liquid “photo-imageable” solder mask. After application, the solder mask coating is dried to remove volatile organic solvents from the film. A solder mask pattern or artwork is then placed onto the board to protect certain areas from curing (hardening) when exposed to ultraviolet light. Finally, after ultraviolet curing, the PCB is placed in a developing solution to remove any uncured solder mask and reexpose those copper areas to which electronic components will be attached.

Our patient was likely sensitized to epoxy components in the solder mask as these types of paints and

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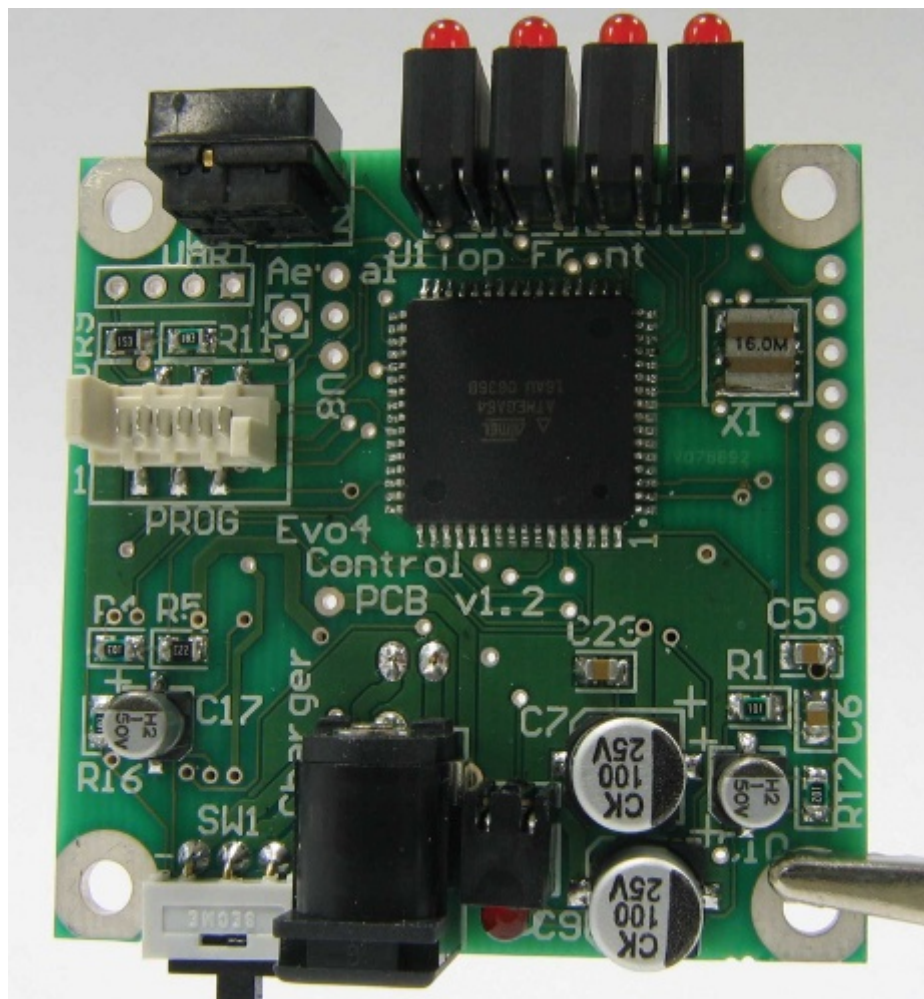


Figure 1. An example of a printed circuit board assembly with a green solder mask coating protecting underlying copper pathways. Electronic components are soldered onto the board at designated sites after the area is cleaned with soldering flux. Text may be added through silk screen printing.

finishes use low-molecular-weight epoxy resins that have greater sensitizing potential than their high-molecular-weight counterparts that are used in other products (such as PCB substrate material).¹ Given the extent of the patient's facial involvement, it is likely that there was also an airborne component to his dermatitis, which has been reported previously in regard both to epoxy resin systems and to epoxy acrylates.² Placing the solder mask artwork prior to curing required our patient to work very closely with the PCB (often with the aid of a magnifying glass to ensure correct alignment), which strengthens the case for an airborne contribution to his allergic contact dermatitis.

Because the names of the specific epoxy acrylate compounds in the solder mask coating are considered proprietary, it is difficult to determine whether our patient's reactions to both epoxy resin and Bis-GMA (an epoxy methacrylate) represent a cross-allergy or reactions to separate exposures. However, several recent studies

indicated that concomitant Bis-GMA and epoxy resin patch-test reactions often represent epoxy resin-induced immunologic cross-reactivity.^{3,4} Although only one other report (to our knowledge) has implicated PCB solder mask coating as an epoxy resin sensitizing agent, solder mask coating remains an important potential source of contact allergy given its widespread use within the PCB industry.⁵

Pearl

This case highlights the potential for epoxy resin in solder mask coatings to cause allergic contact dermatitis among those working in the PCB industry.

References

1. Cao LY, Sood A, Taylor JS. Hand/face/neck localized pattern: sticky problems—resins. *Dermatol Clin* 2009;27:227–49.
2. Santos R, Goossens A. An update on airborne contact dermatitis: 2001–2006. *Contact Dermatitis* 2007;57:353–60.

3. Aalto-Korte K, Jungewelter S, Henriks-Eckerman ML, et al. Contact allergy to epoxy (meth)acrylates. *Contact Dermatitis* 2009;61:9–21.
4. Geier J, Lessmann H, Uter W, Schnuch A. Are concomitant patch test reactions to epoxy resin and BIS-GMA indicative of cross-reactivity? *Contact Dermatitis* 2007;57:376–80.
5. Jolanki R, Kanerva L, Estlander T, Tarvainen K. Concomitant sensitization to triglycidyl isocyanurate, diaminodiphenylmethane and 2-hydroxyethyl methacrylate from silk-screen printing coatings in the manufacture of circuit boards. *Contact Dermatitis* 1994;30:12–5.

Shiitake Mushroom Dermatitis

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Précis

The ingestion of raw or undercooked shiitake mushrooms (*Lentinula edodes*) may result in an uncommon and characteristic linear or “flagellate” dermatitis.

Discussion

A 28-year-old Caucasian male presented with a 2-day history of a moderately pruritic eruption involving the trunk and bilateral lower extremities. He denied having any fever or other constitutional symptoms. The eruption, which the patient first noticed on the bilateral anterior lower legs, quickly spread to involve the thorax and lower back. The patient had consumed a self-prepared soup that contained one cup of shiitake mushrooms 3 days before and on the day of the onset of the eruption. The recipe called for the mushrooms to be cooked in the boiling soup for several minutes (< 5 minutes). The patient had handled the mushrooms with his bare hands but claimed he had experienced no pruritus on his hands or fingers. He also reported having eaten shiitake mushrooms in the past but only in dishes he had not prepared, and he could not particularly recall how well the mushrooms had been cooked in those dishes.

Physical examination revealed 2-to-3 mm erythematous flat-topped scaly papules linearly arranged on the lower back (Fig 1) and thorax (Fig 2). On the shins (Fig 3) and dorsal feet were diffuse pink papules numbering in the hundreds. There were several papules on his arms; the face and chest were spared. Given the patient's history and concordant physical examination results, shiitake mushroom dermatitis was diagnosed. The eruption spontaneously resolved over the following week without treatment.

Shiitake mushrooms have been reported to cause a number of reactions depending on the type of exposure. Inhalation of the spores may result in allergic alveolitis,¹ and skin contact with the mushrooms can result in a contact dermatitis.² The ingestion of shiitake mushrooms (as reported herein) has been known to result in a characteristic “flagellate” dermatitis with linearly arranged papules that characteristically involve the trunk, appear

1 to 2 days after the consumption of raw or undercooked shiitake mushrooms, and resolve with avoidance of the mushroom. The pathogenesis of shiitake mushroom dermatitis is debated, but lentinan (a β -glucan found in shiitake mushrooms) has been implicated as the causative factor, and a toxic reaction is favored (shiitake mushroom-induced toxicoderma)³ although a systemic allergic contact dermatitis phenomenon has been postulated.⁴ Our case supports a toxic reaction given that the patient had no prior skin exposure to shiitake mushrooms and given that handling the mushrooms did not cause symptoms consistent with allergic contact dermatitis. Furthermore, the lentinan polysaccharide found in shiitake mushrooms undergoes a thermally induced conformational change after



Figure 1. Linearly arranged erythematous papules on the right lower back.

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Figure 2. Linearly arranged erythematous papules on the right lateral thorax.



Figure 3. Diffuse pink papules on the left shin.

exposure to temperatures of 130° to 145°C,⁵ supporting the notion that ingesting raw or undercooked (not well-cooked) shiitake mushrooms may result in dermatitis.

The differential diagnostic list for such a characteristic eruption is short. A contact dermatitis spread by contaminated fingers was considered in this patient's case. Dermatographism may display similar linear configurations but should be readily reproducible and more transient. Bleomycin has also been shown to result in a similar "flagellate" dermatitis,⁶ supporting the importance of thorough history taking. Taken alone, the diffuse papules noted on the lower extremities were not classic symptoms of shiitake mushroom dermatitis and would constitute an atypical presentation.

Zebra

Careful history taking and recognition of the characteristic linear arrangements on the trunk are clues to a diagnosis of

shiitake mushroom dermatitis, a "zebra" among diagnoses.

References

1. Tarvainen K, Salonen JP, Kanerva L, et al. Allergy and toxicodermia from shiitake mushrooms. *J Am Acad Dermatol* 1991;24:64–6.
2. Ueda A, Obama K, Aoyama K, et al. Allergic contact dermatitis in shiitake (*Lentinus edodes* [Berk] Sing) growers. *Contact Dermatitis* 1992;26:228–33.
3. Nakamura T. Shiitake (*Lentinus edodes*) dermatitis. *Contact Dermatitis* 1992;27:65–70.
4. Kopp T, Mastan P, Mothes N, et al. Systemic allergic contact dermatitis due to consumption of raw shiitake mushroom. *Clin Exp Dermatol* 2009;34:e910–3.
5. Wang X, Xu X, Zhang L. Thermally induced conformation transition of triple-helical lentinan in NaCl aqueous solution. *J Phys Chem B* 2008;112:10343–51.
6. Chen YB, Rahemtullah A, Breeden E, Hochberg EP. Bleomycin-induced flagellate erythema. *J Clin Oncol* 2007;25:898–900.