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Application News

No. P114

EPMA-8050G Electron Probe Microanalyzer

Analysis of Inorganic Antimicrobial Agents

Introduction

In response to a heightened awareness of cleanliness, antimicrobial treatment has been applied not only to processed goods such as daily necessities, home electrical appliances, and textiles, but also to cosmetic and quasi-drug additives in recent years. Inorganic antimicrobial agents include a type which utilizes an antimicrobial ion chemical (antimicrobial activity: $Ag^{+} \gg Cu^{2+}$, Zn^{2+}) fixed by the surface or layered structure of a carrier such as zeolite, a phosphate compound, or a silicate compound, and a type which utilizes the photocatalytic reaction of titanium oxide (TiO_2). Phosphate compounds have diverse types of crystal structures, for example, a layered structure or a glass structure. In phosphate-type antimicrobial agents, an antimicrobial ion such as the Ag^{+} ion, Zn^{2+} ion, or Cu^{2+} ion is supported by these structures. Inorganic phosphates with good biocompatibility such as hydroxyapatite also exist, and many antimicrobial agents using this compound have also been commercialized.

This article introduces an example of an analysis of an antimicrobial gel and an antimicrobial filter using the Shimadzu EPMA-8050G EPMA™ electron probe microanalyzer.

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Antimicrobial Hand Gel

The frequency of hand disinfection is increasing steadily as part of new lifestyles, but many of these hand disinfection products are alcohol-based antibacterial sprays or gels. Recently, antibacterial gel products containing antimicrobial agents have also been developed. In this experiment, we analyzed the antimicrobial agents added to these gels.

Fig. 1 shows fine particles of zinc oxide (ZnO) supported by zeolite. In this substance, Zn ions are exchanged by the ion conversion function of zeolite. The existence of particles with a size of approximately 1 µm and a small amount of Zn on the entire surface of the zeolite can be confirmed. Although explanations of the antimicrobial mechanism include an eluted ion theory and an active oxygen theory, elucidation and research on this mechanism of its antimicrobial action are underway.

Portable hand gels are also used when going out and in other situations where handwashing would be difficult. Fig. 2 is an example of observation of dirt adhering to a fingertip. The dirt on the fingertip before handwashing and after hand disinfection with a hand gel was compared by the fingerprint traces adhering to metal. In case of cleaning with the gel without handwashing, much of the dirt flows once, but it is thought that this simply results in a condition of overall thinning. The degree of dirt removed is also thought to differ depending on the amount of gel used in cleaning, the cleaning method, and the composition and amount of the dirt.

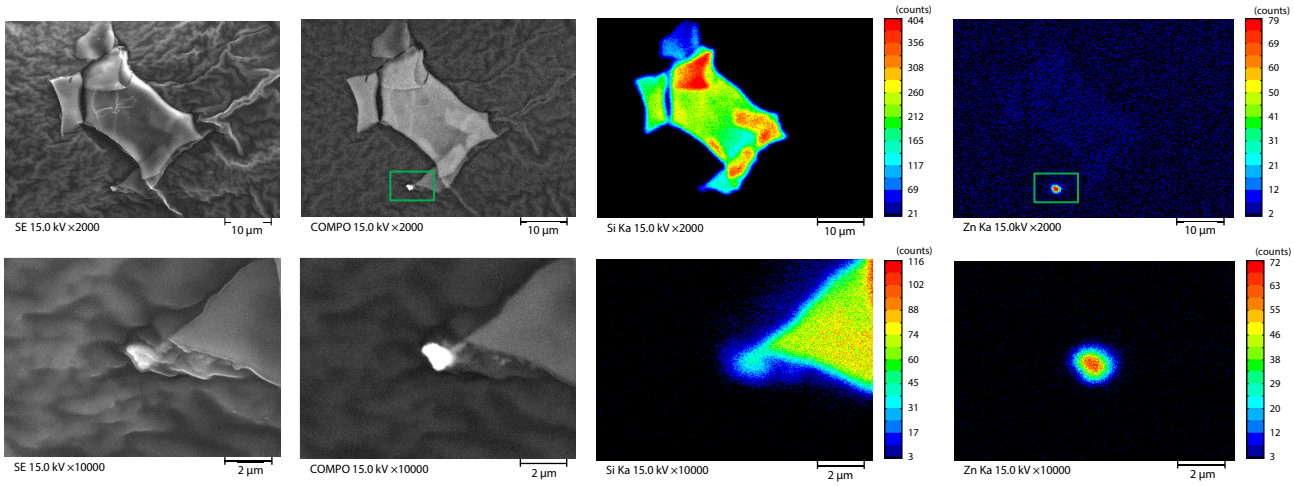

Fig. 1 Fine Particles of ZnO Supported by Zeolite

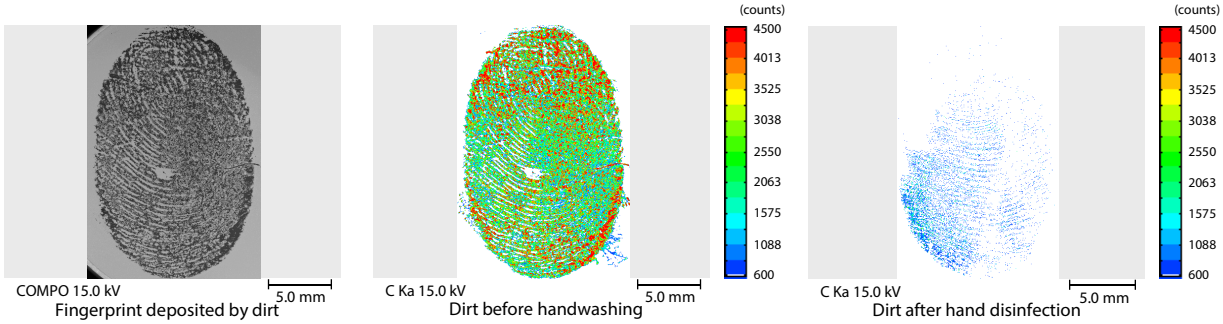

Fig. 2 Dirt Adhering to Fingertip

Apatite-Type Antimicrobial Agents

Hydroxyapatite (HAp) consists of calcium hydroxyphosphate ($Ca_{10}(PO_4)_6(OH)_2$) with good biocompatibility and is used as a ceramic biomaterial, for example, in medical materials and toothpastes. In HAp-type antimicrobial agents, silver (Ag), which has an antibacterial property, is supported by HAp as the carrier of the antimicrobial agent. HAp-type antimicrobial agents are also used in medical-related fields and cosmetic products.

Fig. 3 shows a mapping analysis of an apatite-based antimicrobial agent consisting of multiple materials, namely, hydroxyapatite, which has high adsorptive power, TiO_2, a photocatalyst that decomposes adsorbed matter to harmless substances in the presence of light, and silver, which has an antibacterial property. It can be understood that Ag, which has a high antibacterial property, is distributed as coarse particles and fine particles.

In Fig. 4, about 200 nm TiO_2 and HAp particles are mixed in a complex manner and have a strongly irregular surface profile, but it is possible to observe the distribution of fine Ag particles with a size of about 70 nm.

Conclusion

In inorganic antimicrobial agents, the antimicrobial ion fixed by the carrier differs depending on the type of carrier, and the effects and applications of the antimicrobial agents are also different. The size of the antimicrobial ion and the quantity distribution of the ion fixed by the carrier can be captured and evaluated by EPMA. Various aspects of the antimicrobial mechanism remain to be elucidated, and EPMA is being used in research to clarify those issues.

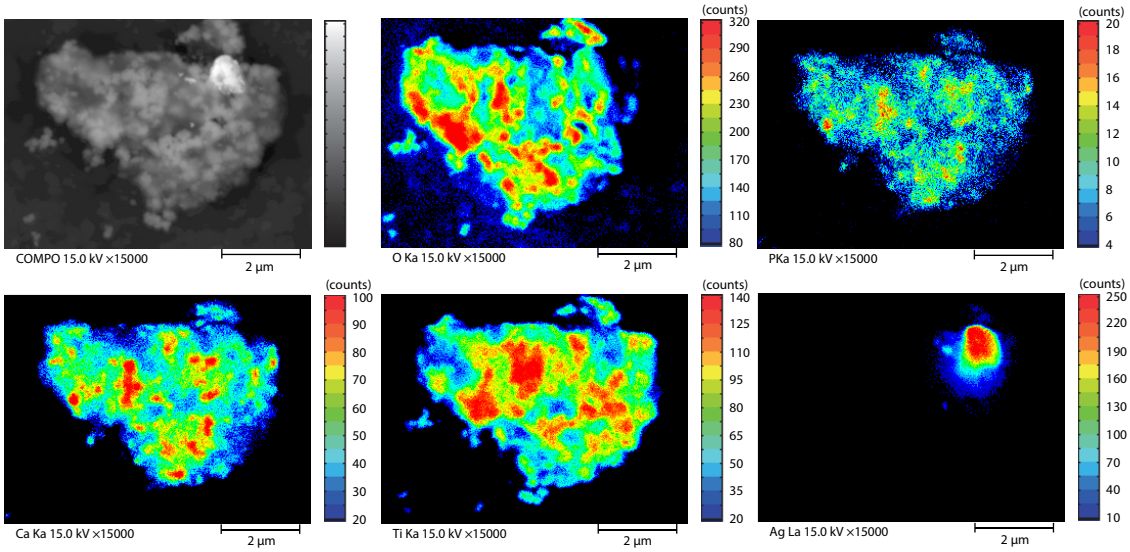

Fig. 3 Mapping Analysis of Apatite-Type Antimicrobial Agent

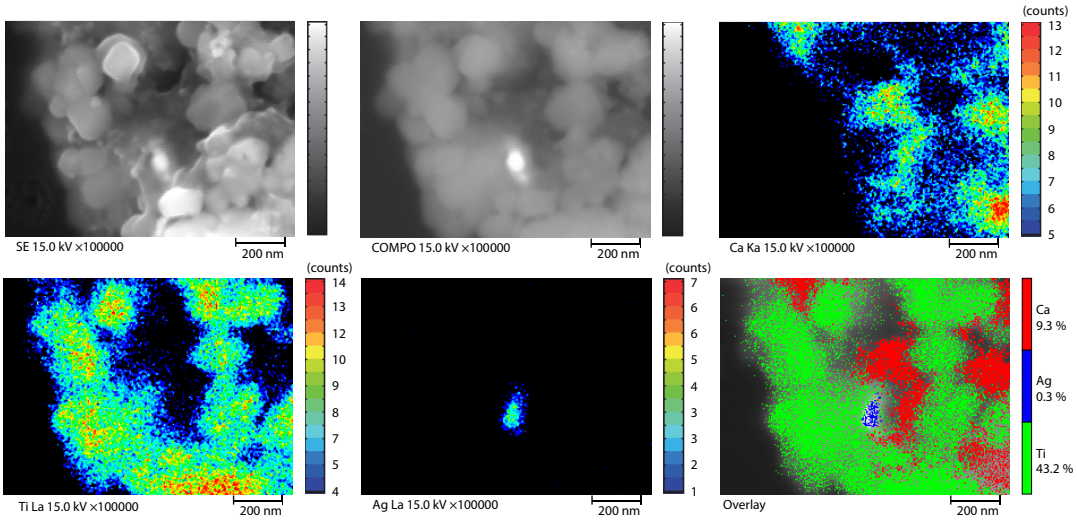

Fig. 4 Fine Ag Particles of Antimicrobial Agent

<Reference>
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