# FUJIFILM's antibacterial technology – 'HYDRO AG'

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## 1. Introduction

Healthcare-Acquired Infections (HAI), are infections patients develop while receiving treatment in healthcare facilities for other medical conditions, they are leading causes of extended hospital stays, increased medical costs, and preventable deaths in the United States for patients in the hospital. The U.S. Centers for Disease Control reports 648,000 patients per year acquire infections during hospital stay and 75,000 of those patients die with those infections. Effectively managing HAIs is serious and a key Process of Care measure in today's Value-Based Purchasing Domains of Care.

Given the large numbers of patients that pass through the radiology department daily or have x-ray exams performed portably, contamination of radiographic equipment and accessories are unavoidable. Even with standard preventative measures, such as hand hygiene, use of protective barriers and antiseptic cleaning of surfaces, neither contact precautions nor antiseptic cleaning can totally eliminate all bacteria in the hospital.

For typical wet disinfectant wipes to be effective as defined by the wipe manufacturers, EPA mandated requirements regarding specific protocols must be followed for effective use of these disinfectants. This includes requirements such as the minimum amount of time, in minutes (some require as much as 2-4 mins), a particular disinfectant must remain "visibly wet" in order to maximize its effectiveness against targeted microorganisms. Failing to follow the specified EPA approved disinfecting instructions, exposes patients and hospital staff to exposure of potentially infectious agents.

Against this background, FUJIFILM developed a new application of its antibacterial technology, "HYDRO AG" for FUJIFILM's FDR D-EVO II DR flat panel digital x-ray detectors. HYDRO AG technology is based on FUJIFILM's culmination of unique knowledge of silver (Ag) applications through an extensive history in chemical and film engineering originating in the photographic field, its current precision nano technology capabilities, and Toyama Chemical'sA (a FUJIFILM group company) antibacterial and pharmaceutical knowledge Among the wide-range of conventional antibacterial materials, silver ions are known to possess effective antibacterial properties across a wide spectrum of bacteria, drug-resistant bacteria, microorganisms, viruses and mold.

## 2. Hydro Ag Technology

### 2.1 Mechanism

There are different theories regarding how silver ions kill bacteria: (i) silver ions bond with DNA or RNA that inhibit cellular growth; (ii) silver ions bond with respiration enzymes on the bacteria's surface and fatally disrupt cellular respiration **(Figure 1)**.

The action of silver ions on bacteria is most effective when they remain in high concentration at the surface layer, increasing the probability of contact between the bacteria and silver ions. Under normal conditions, the silver ion concentration diminishes as they continually bind with bacteria on the surface, because the ions are not actively replaced at the surface layer. FUJIFILM developed a method of actively replenishing

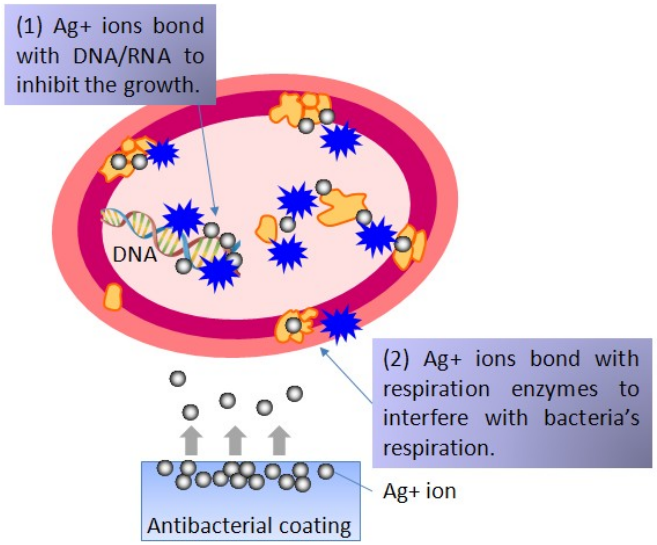


**Fig.1** Schematic of antibacterial mechanisms

the silver ion layer by replacing ions from within the surface binder layer itself.

**Figure 2** demonstrates the differences between conventional silver ion bacterial activity and HYDRO AG. In a conventional Ag+ antibacterial coating, silver ions binding to bacteria are concentrated at the layer surface only. To release additional silver ions from the binder material, moisture is required. A conventional polymer base do not release additional Ag+ antibacterial agents inside the layer due to its poor hydrophilic or water-absorbing properties required to free more silver ions. The release of additional silver ions to continuously suppress bacteria growth only occurs when sufficient moisture is present to release stored ions from the binder material.

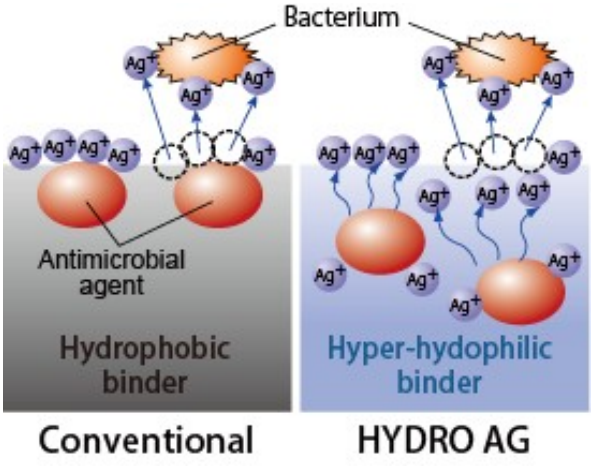


**Fig.2** Schematic of silver ions migration in conventional antibacterial coating and Hydro AG

HYDRO AG, in contrast, employs a hyper-hydrophilic binder, one that is extremely interactive with water. Not only does it enable moisture applied to the surface of the coated layer to affect the release of Ag+, but it also enables moisture to release the Ag+ antibacterial solution from within the coated layer. The unique hyper-hydrophilic properties of the binder material allow active replenishment of the antibacterial layer. The required moisture is supplied from ambient humidity (ex. 25C, 50% RH) or directly with a wet wipe from daily surface cleaning. Therefore, the high Ag+ concentration on the surface layer maintains to exert both the highest as well as long lasting antibacterial effect.

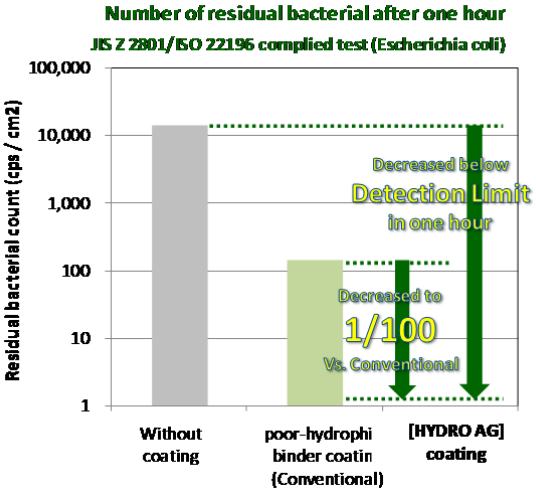


**Fig.3** Performance of HYDRO AG under ISO22196 compliant test [1]

### 2.2 Antibacterial Performance

FUJIFILM evaluated HYDRO AG performance based upon ISO22196 / JIS Z 2801 [Antibacterial activity value in 24 hours: "2(killed 99% of bacterial)], HYDRO AG technology demonstrated to be 100 times more effective compared to conventional silver ion technology, ["4(killed 99.99% of bacteria) within an hour] **(Figure 3)**.

ISO22196 / JIS Z2801 test conditions for measuring the effects of HYDRO AG utilize more water than typically expected in a hospital environment. These conditions created an advantage for HYDRO AG which uses a hydrophilic or water-absorbing binder therefore FUJIFILM tested HYDRO AG under conditions closer to an actual hospital environment.

After preparing a HYDRO AG sample surface with a bacteria mist and drying it to remove any excess moisture, the sample was kept under 25oC, 50%RH for six hours. Under these minimum water conditions, HYDRO AG technology demonstrated at least 100 times more antibacterial performance compared to traditional Ag coatings and 10,000 times more protection compared to surfaces with no coating applied **(Figure 4)**.

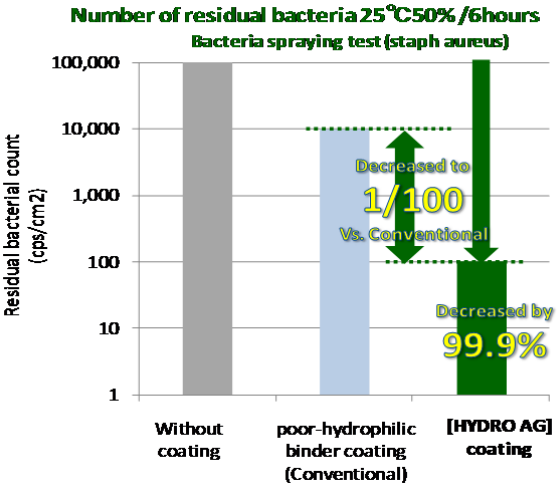


**Fig.4** Performance of HYDRO AG under simulated actual condition test [2]

The antibacterial effects of Ag+ technology have been widely known for centuries and it is expected that the unique HYDRO AG application of these effects will play an important role in breaking a link in the chain of infection in today's clinical environment. Hydro AG is not a substitute for normal infection control precautions, but can provide an added safety measure to help prevent the colonization of harmful microorganisms on the surfaces it's applied to. HYDRO AG has shown antibacterial effects **(Figure 5)** for the following bacteria: Staphylococcus Aureus (Staph), Escherichia coli (E coli), Pseudomonas aeruginosa, Vancomycin-resistant enterococcus (VRE), and Methicillin-resistant staphylococcus Aureus (MRSA). Pseudomonas aeruginosa, VRE, and MRSA are drug-resistant bacteria.

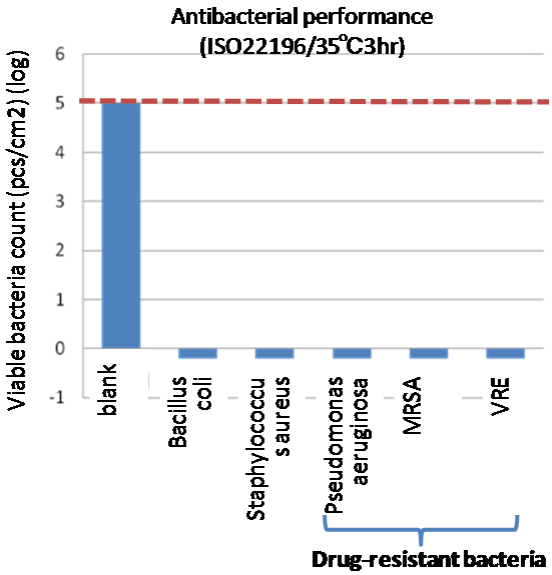


**Fig.5** Performance of HYDRO AG for some kinds of bacteria [3]

## 3. CONCLUSION

With even the strictest of infection control procedures any x-ray department surface or accessory, such as a Digital Radiography detector, may still become contaminated with bacteria. FUJIFILM Hydro Ag technology, with its 99.99% antibacterial properties, coupled with properly followed infection control processes, can work together to provide an added layer of safety in infection control and preventing colonization of bacteria on Fujifilm's FDR D-EVO II digital radiography detector surfaces.

## REFERENCES

1) Report by BOKEN Quality Evaluation Institute. Report ID: 20214016660-1 (Jul 11th, 2014)
2) Report by Kitazato Research Center for Environmental Science. Report ID: 26_0101

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